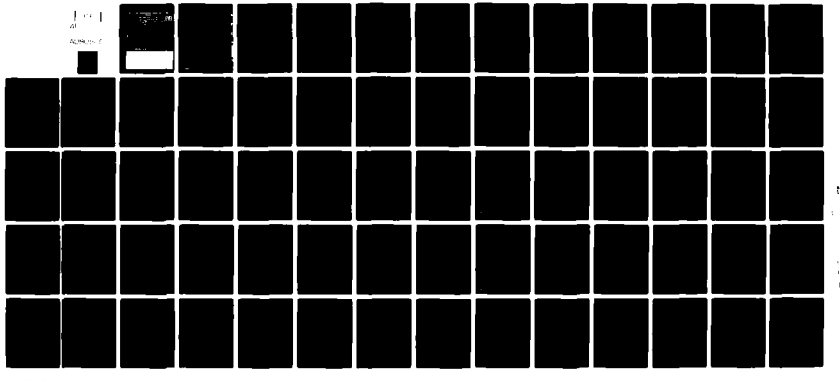
AD-A080 805 ARINC RESEARCH CORP ANNAPOLIS MD F/G 13/10
DESTROYER ENGINEERED OPERATING CYCLE (DDEOC). SYSTEM MAINTENANC--ETC(U)
AUG 79 T PETTY, E FLAMBOE, J C YANCY N00024-78-C-4062
UNCLASSIFIED 1653-07-18-2114 NL



END
DATE FILMED
3-80
DDC

Publication 1653-07-17-2114

DESTROYER ENGINEERED OPERATING CYCLE (DDEOC)

System Maintenance Analysis CG-16 and CG-26 CLASS EXTERIOR COMMUNICATIONS SYSTEM SWAB GROUP 440

SMA 1626-440

REVIEW OF EXPERIENCE

LEVEL II

August 1979

Prepared for
Director, Escort and Cruiser
Ship Logistic Division
Naval Sea Systems Command
Washington, D.C. 20362
under Contract N00024-78-C-4062

ARINC RESEARCH CORPORATION

[redacted]

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 1653-07-17-2114	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)*		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER 1653-07-17-2114
7. AUTHOR(s) T. Petty, E. Flamboe, J. C. Yancy Jr.		8. CONTRACT OR GRANT NUMBER(s) N00024-78-C-4062
9. PERFORMING ORGANIZATION NAME AND ADDRESS ARINC Research Corp. 2551 Riva Road Annapolis, MD 21401		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE August 1979
		13. NUMBER OF PAGES 66
14. MONITORING AGENCY NAME & ADDRESS*(if different from Controlling Office)*		15. SECURITY CLASS. *(of this report)* Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Unlimited

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report, the review of experience, documents the historical maintenance experience for both CG-16 and CG-26 Class exterior communications systems, SWAB group 440. It presents an analysis of the existing maintenance policy and recommends specific maintenance actions and maintenance policy modifications to improve system material condition. It has been developed for NAVSEA 931X, the manager of the Destroyer Engineered Operating Cycle (DDEOC) Program, under Navy Contract N00023-78-C-4062.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

(11)

(6) DESTROYER ENGINEERED OPERATING CYCLE (DDEOC):

SYSTEM MAINTENANCE ANALYSIS
CG-16 AND CG-26 CLASS
EXTERIOR COMMUNICATIONS SYSTEM
SWAB GROUP 440
SMA 1626-440

REVIEW OF EXPERIENCE

(11) August 1979

(12) 66

Prepared for

Director, Escort and Cruiser
Ship Logistic Division
Naval Sea Systems Command
Washington, D.C. 20362

under Contract (15) N00024-78-C-4062

by

(16) T. Petty
E. Flamboe
J. C. Yancy, Jr

ARINC Research Corporation
a Subsidiary of Aeronautical Radio, Inc.
2551 Riva Road
Annapolis, Maryland 21401

Publication 1653-07-17-2114
(14)

400 247

80 2 15 046

Prepared under Contract N00024-78-C-4062,
which grants to the U.S. Government a
license to use any material in this publi-
cation for Government purposes.

FOREWORD

This report, the review of experience, documents the historical maintenance experience for both CG-16 and CG-26 Class exterior communications systems, SWAB group 440. It presents an analysis of the existing maintenance policy and recommends specific maintenance actions and maintenance policy modifications to improve system material condition. It has been developed for NAVSEA 931X, the manager of the Destroyer Engineered Operating Cycle (DDEOC) Program, under Navy Contract N00024-78-C-4062.

SUMMARY

The goal of the Destroyer Engineered Operating Cycle (DDEOC) Program is to effect an early improvement in the material condition of ships at an acceptable cost, while maintaining or increasing their operational availability during an extended operating cycle. In support of this goal, system maintenance analyses (SMAs) are being conducted for selected systems and subsystems of designated surface combatants. The principal element of an SMA is the review of experience (ROE). This report documents the ROE for the CG-16 and CG-26 Class exterior communications systems, SWAB group 440.

The ROE is an analysis of the impact of the historical maintenance requirements on the operational performance and maintenance program of a ship system and the significance of these requirements to the DDEOC Program. The report documents a recommended system maintenance policy and specific maintenance actions best suited to meeting DDEOC goals.

The ROE for the exterior communications systems included an analysis of all available maintenance data sources. The documented maintenance experience of the system was reviewed through analysis of data from the maintenance data system (MDS), casualty reports (CASREPs), and system overhaul records. Initial findings from these sources were correlated with planned maintenance system (PMS) requirements, the alterations program, and system technical manuals. Selected ships were surveyed and discussions were held with appropriate technical groups to validate identified maintenance requirements, to identify undocumented maintenance requirements, and to determine the status of current and planned actions affecting the exterior communications systems. All findings were evaluated and appropriate conclusions were developed.

A recommended system maintenance policy was defined on the basis of these conclusions; recommendations were then made to implement the policy by periodically accomplishing specific types of corrective maintenance actions. These actions were documented for inclusion as tasks in the CG-16 and CG-26 Class maintenance plans. Also included, as appropriate, were recommendations for improving system preventive maintenance; integrated logistics support; reliability, maintainability, and availability; and depot- and IMA-level capabilities. Implementing these combined recommendations will minimize the adverse impact of corrective maintenance requirements on the extended operating cycle.

The major findings and conclusions of this ROE for the CG-16 and CG-26 Class exterior communications systems are summarized as follows:

- The ship's force personnel have the capability to perform most major maintenance actions for the radio systems.
- The teletype systems usually require IMA assistance in accomplishing major repairs because of the lack of shipboard facilities.
- The majority of the radio equipment will not require major overhaul at baseline overhaul (BOH) and regular overhaul (ROH); class C repairs should be sufficient.
- The antennas will require class B overhaul at BOH and ROH.
- Ship's force personnel are not adequately trained to maintain the AN/SRA-33 antenna coupler.
- The teletype systems will require class B overhaul at BOH and ROH in addition to intracycle requirements for class C repairs.
- Standardization of the model 28 teletype suites should improve reliability and maintainability of the teletype equipment.
- Replacement of the AN/UGC-16 teletype with the AN/UGC-6K should improve reliability and maintainability of the teletype equipment.
- The labeling of different R-1051( )/URR receivers and the respective modules with warning labels that show model type and module substitution applicability should decrease the parts usage and improve the reliability of the R-1051( )/URR receivers.

Reliable operation of the exterior communications systems can be expected throughout an extended operating cycle if the recommendations contained in this study are implemented and existing PMS maintenance requirements, as modified by recommendations of this report, are adhered to.

CONTENTS

CONTENTS (continued)

CONTENTS (continued)

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

System maintenance analyses (SMAs) are being conducted as part of the Destroyer Engineered Operating Cycle (DDEOC) Program, managed by NAVSEA 931X. The principal element of an SMA is the review of experience (ROE) of selected systems and subsystems of program-designated surface combatants. This report documents the ROE for the CG-16 and CG-26 Class exterior communications systems, SWAB group 440, which were selected for analysis because equipments of these systems have been major contributors to the CG-16 and CG-26 Class maintenance burden.

1.2 PURPOSE AND SCOPE

The ROE is an analysis of the impact of the historical maintenance requirements on a ship system's operational performance and maintenance program. It serves as a vehicle for documenting the significance of historical maintenance requirements to the DDEOC Program.

The objective of the ROE is to define and document a maintenance program for CG-16 and CG-26 Class ships that will prevent or reduce the need for unscheduled maintenance while improving material condition and maintaining or increasing ship availability throughout an extended ship operating cycle. The maintenance program defined and documented in an ROE for a selected equipment will be the basis for maintenance tasks to be developed for inclusion in the class maintenance plan (CMP).

The analysis documented in this report is specifically applicable to the exterior communications systems, SWAB group 440, of the CG-16 and CG-26 Class ships. This analysis used all available documented data sources from which system maintenance experience could be identified and studied. These included maintenance data system (MDS) data, casualty reports (CASREPs), Board of Inspection and Survey (INSURV) reports, departure reports, ship's alteration and repair packages (SARPs), planned maintenance system (PMS) requirements data, system alteration documentation, and system technical manuals. Sources of undocumented data used in this analysis included discussions with ship's force and cognizant Navy technical personnel.

1.3 REPORT FORMAT

The remaining chapters of this report describe the analysis approach (Chapter Two), briefly present the significant system maintenance experience and discuss essential maintenance requirements (Chapter Three), and summarize the conclusions and recommendations derived from the analysis (Chapter Four).

CHAPTER TWO

APPROACH

2.1 OVERVIEW

This chapter describes the approach followed in performing the ROE for equipments and subsystems in the exterior communications systems, SWAB group 440. These systems were identified for analysis in the *DDEOC Selected Items for Analysis List, CG-16 and CG-26 Classes*, ARINC Research Publication 1653-06-TR-1875. Primary data sources were identified in section 1.2 The data were used to identify, define, and analyze maintenance requirements that have significantly affected the system's operational availability and material condition. A recommended maintenance strategy and implementation procedures were formulated on the basis of analysis results. The major steps of the analysis were as follows:

- Relevant documented and undocumented historical maintenance data were compiled for the selected equipments or subsystems.
- These data were analyzed to identify and define recurring maintenance requirements that have a significant impact on the operational availability and material condition of these equipments or subsystems.
- The results of ROE analyses were compared with results of previously completed analyses of identical or functionally similar equipment or subsystems (on other classes of ships) to determine if previously identified maintenance strategies and implementation recommendations apply to CG-16 and CG-26 Class ships.
- If previously developed maintenance strategies and recommendations were determined to be applicable to similar equipment or subsystems of the CG-16 and CG-26 Class ships, they were identified and documented in this report. CMP tasks previously developed were modified to reflect their applicability to these two ship classes.
- Where previously developed maintenance strategies and implementation recommendations were not applicable to CG-16 and CG-26 Class ships, a detailed maintenance analysis was conducted to develop the maintenance strategy to be recommended and the steps to be employed in implementing that strategy.

2.2 DATA COMPILATION

The analysis began with the compilation of comprehensive data on the maintenance history of the system. The data file assembled consisted of four key elements: an MDS data bank, a CASREP narrative summary, a system overhaul experience summary, and a system ShipAlt summary. A library of appropriate technical manuals, bulletins, and related documents was also assembled. The MDS data bank was compiled by examining all MDS data reported for the CG-16 and CG-26 Classes from 1 January 1970 through 31 December 1977. In the case of the CG-16 Class, MDS data reported between 1 January 1970 and completion of modernization were not considered. Thus the data bank for ships of this class includes only the MDS reported maintenance actions occurring between the end of modernization and 31 December 1977. CASREP information was obtained by reviewing CASREPs against the various exterior communication systems' equipments during the data period 1 January 1972 through 31 August 1978. Overhaul information was obtained from authorized SARPs and departure reports for ships of both classes.

2.3 MAINTENANCE DATA ANALYSIS

Recurring maintenance requirements affecting the availability and material condition of subsystems or equipments were identified by screening data obtained from the above-described sources, as well as from ship surveys, discussions with Navy technical personnel, and NAVSEA special-interest programs.

MDS data provided the initial and primary source of information screened. The resulting data base includes all part and labor records, as well as narrative material, describing maintenance actions reported against system components. The purpose of the screening process was to identify the maintenance actions that had been reported against the exterior communication systems' equipments.

Preliminary analysis of each of the equipments was directed toward determining the historical maintenance profile in terms of reported man-hours per equipment per operating year, types of maintenance actions commonly recurring, type and number of repair parts used, CASREP frequency, and past ROH experience. The historical maintenance profile was then compared with similar information developed for identical or functionally similar subsystems or equipments previously subjected to detailed analysis during the performance of ROEs for FF-1052 and DDG-37 Class ships. Further analysis was not conducted where the results of this comparison showed that the maintenance profile for the CG-16 or CG-26 Class equipment was essentially the same as that of an identical or functionally similar subsystem or equipment previously analyzed on another ship class. Instead, the maintenance strategy and implementation recommendations developed for the same or similar equipment on a previously analyzed ship class were identified as being applicable to the CG-16 or CG-26 Class ships, as documented in this report.

Where the results of the historical maintenance profile comparison did not reveal a marked similarity, a detailed maintenance requirements engineering analysis was conducted. Initially, man-hour and parts-usage trends were examined to determine if either parameter increased as a function of time after overhaul, indicating wear-out or deterioration. If no increasing trend was evident, it was assumed that the equipment or subsystem could be expected to continue to operate satisfactorily, exhibiting its current maintenance characteristics throughout an extended operating cycle. If an increasing trend was evident, additional analysis was conducted to identify apparent problems and establish the time at which planned restorative maintenance would be required to prevent an unacceptable increase in maintenance burden and downtime.

Detailed analysis was directed toward defining each recurring significant maintenance requirement in terms of several specific factors: the effect of the maintenance action on the subsystem or equipment, the interval between occurrences of the action, the redundancy of the affected subsystem or equipment, the criticality to mission accomplishment, the resources required to perform the necessary corrective maintenance, and the expected subsystem or equipment downtime.

Once the factors associated with the historically required maintenance actions were identified, the individual types of historical maintenance actions were analyzed to identify any design or maintenance-related problems that would have an impact on the selection of a maintenance strategy. Solutions were then sought by examining each problem in relation to the extent to which it was recognized and its amenability to established types of corrective action. These analysis criteria are expressed in the following questions:

- Is the problem known to the Navy technical community, and has a solution been proposed or established?
- Will a design change reduce or eliminate the problem?
- Is the problem PMS-related? Can it be reduced or eliminated by changes to PMS? (These changes might include adding or deleting requirements, changing periodicity, or developing material condition assessment tests and procedures.)
- Can the problem be reduced or eliminated by improving the system's integrated logistic support (ILS) at the ship's force level?
- Can the problem be reduced or eliminated by improving intermediate maintenance activity (IMA) or depot-level capabilities?
- Can this problem be reduced or eliminated by revising the existing maintenance strategy?

An affirmative answer to any question resulted in analysis of the effects of the solution and in an estimate, when possible, of the cost to implement the solution. A negative answer prompted the engineer to go to the next question. After all the questions concerning an individual problem were asked, the alternative solutions were evaluated and the most acceptable

alternatives defined and documented as recommendations. These recommended solutions to identified design or maintenance-related problems were then considered during the definition of the maintenance strategy. A further series of implementation recommendations was then formulated to accomplish the objectives of the maintenance strategy selected for the engineered operating cycle (EOC).

2.4 MAINTENANCE PROGRAM DEFINITION

The recommended maintenance program stems directly from the subsystem and equipment maintenance strategies identified by the analysis. The total maintenance program includes both the scheduled and unscheduled preventive maintenance and "engineered" and "qualified" corrective maintenance required to maintain the subsystems and equipments at acceptable levels of material condition and availability over an extended operating cycle. Engineered corrective maintenance comprises those tasks that are well defined and must be accomplished periodically. Qualified tasks are those nonspecific repairs that are likely to be required but cannot be characterized precisely as to nature and frequency.

In development of the implementation recommendations, the results of the analysis were used to identify specific corrective maintenance tasks that would be required periodically. Once these tasks were identified, the frequency of accomplishment, the manpower resources required for accomplishment, and the maintenance level required to perform the work were determined for engineered tasks. Qualified maintenance tasks were also identified, on the basis of historical data, to reserve blocks of man-hours at specified intervals to complete required but nonspecific Class C repairs on the subsystems or equipments under analysis.

Where appropriate, additional recommendations were developed for improving subsystem or equipment reliability, availability, and maintainability; system preventive maintenance; logistics support; and IMA- or depot-level capabilities.

The steps described in this section effectively define the maintenance program recommended for the subsystems and equipments identified for detailed analysis in this ROE. Recommendations resulting from this analysis will be used to develop the CMP.

CHAPTER THREE

ANALYSIS RESULTS

3.1 OVERVIEW

This chapter presents the results of an analysis of the corrective and preventive maintenance experiences for selected items of the exterior communications systems (SWAB group 440) installed on CG-16 and CG-26 Class ships. The exterior communications systems include the high frequency (HF) radio systems, the ultra-high frequency (UHF) radio systems; the very-high frequency (VHF) radio systems, the low frequency (LF) radio systems, and teletype and facsimile equipments. Collectively, these equipments provide 0-400 MHz transmission and reception of single sideband (SSB), continuous wave (CW), amplitude modulation (AM), or radio-teletype frequency shift keying (FSK).

These equipments were selected from the *Selected Items for Analysis Lists, CG-16 and CG-26 Classes* (ARINC Research Publication 1653-06-TR-1875, February 1979) on the basis of their respective contributions to the total class maintenance burden as determined by their individual maintenance burden factor (MBF) rankings. The resulting maintenance burden factors reflect the total annual man-hours devoted to corrective or preventive maintenance of equipments included in a specific SWAB category by the combined ships of the class. A total of 123 and 136 equipments were ranked for the CG-16 and CG-26 classes, respectively. The ranking of the SWAB categories represents the preventive and corrective maintenance burden contribution of each SWAB category relative to the total class burden. Three categories of information were used to determine this ranking: (1) the ship's force and intermediate maintenance activity (IMA) corrective maintenance man-hour burden (MBF_{CM}) reported in the maintenance data system (MDS), (2) the annual planned maintenance system (PMS) man-hour burden (MBF_{PM}) as determined from equipment maintenance requirement cards (MRCs), and (3) the average number of man-days required for equipment repair during regular overhaul (ROH) as reported in class repair profiles. A summary of these data for the selected exterior communications systems is presented in table 3-1, together with their relative corrective and preventive maintenance burden rankings.

Sections 3.2 through 3.13 document the results of the maintenance analyses performed for the selected equipments of the CG-16 and CG-26 Class exterior communications systems.

Table 3-1. DATA SUMMARY OF SELECTED EXTERIOR COMMUNICATIONS SYSTEMS FOR THE CG-16 AND CG-26 CLASS SHIPS

SWAB Number	Burden Rank Within Ship		Selected Equipment	Applicable APLs	Class Population	*MBF_{CM} (Man-Hours)	**MBF_{PM} (Man-Hours)	ROH Burden (Man-Days)
	CM	PM						
CG-16 Class								
441	7	17	HF Radio Systems					0
			AN/URT-23	58557823	15	554.3	852.0	
			AN/URT-23A	58557800	4	8.7	227.2	
			R-1051B	81095102	98	596.8	1822.8	
			R-1051	81095100	6	79.1	111.6	
			R-1051D	81101551	8	13.5	148.8	
			R-390A	81039001	24	108.7	328.8	
			AN/SRA-22	57101400	8	57.6	89.6	
			UHF Radio Systems					
			AN/URC-9	58439716	14	735.4	782.2	
			AN/SRA-33	57102300	16	119.1	99.2	
			VHF Radio Systems					
			AN/URC-80	58446701	9	60.3	279.0	
			AN/VRC-46	58841200	7	13.2	131.6	
			LF/VLF Radio Systems					
			AN/WRR-3B	59005302	22	97.7	453.2	
445	31	20	TTY and Facsimile					37
			AN/UGC-6	58138242	21	330.0	1201.0	
			AN/UGC-25	58139025	69	418.1	1060.8	
			AN/UGC-13 AN/UGC-13	58138900 58138950	16	256.0	2196.0	
			AN/UGC-20	58139029	22	77.0	258.0	
CG-26 Class								
441	18	27	HF Radio Systems					285
			AN/URT-23	58557823	12	373.0	681.6	
			AN/URT-23A	58557800	2	78.0	113.6	
			R-1051B	81095102	44	219.0	818.4	
			R-1051	81095100	67	656.9	1246.2	
			R-390A	81039001	64	464.6	876.8	
			AN/SRA-22	57101400	1	284.3	11.2	
			UHF Radio Systems					
			AN/WSC-3	59011020	3	0	547.0	
			AS-390A	59139000	31	59.7	360.0	
			AN/SRA-33	57102300	19	291.3	117.8	
			VHF Radio Systems					
			AN/URC-80	58446701	6	27.3	248.0	
			LF/VLF Radio Systems					
			AN/WRR-3	59005300	21	73.9	432.6	
			AN/SRA-17B	57100810	17	39.5	289.0	
445	16	17	TTY and Facsimile					7
			AN/UGC-6	58138230	18	664.0	912.0	
			AN/UGC-13 AN/UGC-13	58138900 58138950	18	548.5	2406.6	
			AN/UGC-16	58139050	6	121.9	912.0	
			AN/UGC-20	58139020	21	165.2	270.9	
			AN/UGC-25	58139036	7	327.5	95.2	
			AN/UGC-25A	58139025	92	455.1	1251.2	
			TT-192/UG TT-192C/UG	92834300 92834307	24	262.2 84.0	38.0 874.0	

*Combined average for the reported ship's force and IMA corrective maintenance man-hours expended on a particular equipment per year for the entire class population of that equipment.

**Total required annual PMS man-hours as reflected by appropriate MRCs for the entire class population of that equipment.

3.2 AN/URT-23 HF TRANSMITTER (SWAB 441-3)

3.2.1 Background

The AN/URT-23( ) transmitter is a 1,000-watt radio transmitter covering a frequency range from 2 to 30 MHz. This transmitter has the capability of transmitting single sideband (SSB), continuous wave (CW), amplitude modulation (AM), or radio-teletype frequency shift keying (FSK).

During the MDS data period (January 1970 through December 1977), 19 AN/URT-23 transmitters were installed on board various CG-16 Class ships and 14 AN/URT-23 transmitters were installed on board various CG-26 Class ships. A typical quantity of six AN/URT-23 transmitters will be installed on each CG-16 and CG-26 Class ship after BOH. That is, the present quantity of 33 AN/URT-23 transmitters installed aboard the CG-16 and CG-26 Class ships will be increased to approximately 108 AN/URT-23 transmitters after BOH.

3.2.2 Discussion

Two models of AN/URT-23 transmitters are currently installed on board various CG-16 and CG-26 Class ships. These two transmitters (AN/URT-23 and AN/URT-23A) are physically and functionally similar. The primary difference between the two transmitters is that the AN/URT-23 transmitter is not delivered with a power supply and the AN/URT-23A transmitter is delivered with a power supply. Since these two transmitters are similar, the AN/URT-23 and the AN/URT-23A transmitters are discussed together as the AN/URT-23( ) transmitter.

3.2.3 Maintenance Summary

Table 3-2 summarizes the MDS corrective maintenance man-hours reported during the MDS data period for the CG-16 and CG-26 Class AN/URT-23( ) transmitters. It also shows the average number of reported corrective maintenance man-hours per equipment per operating year.

Table 3-2. MAN-HOUR BURDEN SUMMARY FOR CG-16 AND CG-26 CLASS AN/URT-23( ) TRANSMITTERS

Ship Class	Total Population	Number of Ships	Total Ship Operating Years	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Average CM Man-Hours / Equipment Operating Years
CG-16	19	7	21	1,391	1	1,392	24.4
CG-26	14	3	13	1,291	62	1,353	22.3

A comparison of the average corrective maintenance man-hours reported per equipment operating year for the CG-16 and CG-26 Class AN/URT-23( ) transmitters indicates that the maintenance experience for these transmitters was similar for both ship classes.

Tables 3-3 through 3-5 summarize the reported maintenance transactions (JCNs) for the AN/URT-23( ) transmitters on the CG-16 and CG-26 Class ships. The maintenance transactions for the CG-16 and CG-26 Class ships were combined for ease of presentation and discussion, because findings were similar for both ship classes. The following prominent findings are taken from tables 3-3 through 3-5:

- Maintenance actions usually required less than 10 ship's force man-hours.
- Few IMA maintenance actions were required.
- Normal wear and tear was the primary cause of maintenance actions.
- A majority of the maintenance actions required parts replacement.
- Approximately 20 percent of the total JCNs were deferred.

It is concluded from this MDS data summary that ship's force personnel, with minimal outside assistance, are capable of performing most maintenance actions on the AN/URT-23( ) transmitter.

3.2.4 Parts Usage

Parts usage analysis was conducted to delineate problems and causes for maintenance actions as a result of part failures. The MDS parts data were screened to identify significant parts replacements that required replacements by at least 25 percent of the ships on which they were installed. Consumable parts usage such as fuses and light bulbs and nonrepetitive parts usage were not considered to be significant.

Table 3-6 indicates the high-usage parts for the AN/URT-23( ) transmitters on board the CG-16 and CG-26 Class ships. Comparing best replacement factor experienced (BRF_e) on the CG-16 and CG-26 Class ships indicated that 3 of 8 items on the CG-16 Class and 2 of 8 items on the CG-26 Class exceeded the BRF fleet usage. The BRF_e was computed by dividing the annual usage rate by the total population. Two of the items for which BRF_e exceeded BRF were two different NSNs for the RF amplifier module, and the third item was the final transformer.

Investigation into the reasons for the high usage for these items indicated that most of the RF amplifiers were used during the early part of the data period 1971 through 1974. Design changes were made in 1975 that reduced the usage rate from 7.25 per year to one per year for the CG-26 Class. One ship in the CG-16 Class (CG-21) used five (23 percent of the CG-16 Class usage) in one two-month period in 1977. One other ship (CG-16) used 12 (55 percent) before 1975. Since the usage rate for the RF

Table 3-3. MAN-HOUR SUMMARY FOR CG-16 AND CG-26 CLASS AN/URT-23( ) TRANSMITTERS

JCN Type	Man-Hour Distribution		Number of Transactions
	Range of Man-Hours	Percentage of Total JCNs with Man-Hours	
Ship's Force JCNs	0 - 10	87	349
	11 - 30	9	34
	31 or more	4	15
IMA JCNs	0 - 10	3	11
	11 or more	-	-

Total JCNs = 517.
Parts-only transactions = 119 (23%) of total JCNs.
Transactions with reported man-hours = 398 (77%) of total JCNs.
Both ship's force and IMA man-hours may be reported on a particular JCN.

Table 3-4. MDS SUMMARY OF JCN CAUSE AND ACTION TAKEN CODES FOR CG-16 AND CG-26 CLASS AN/URT-23( ) TRANSMITTERS

Data Item	Percentage of Total JCNs with Reported Man-Hours	Number of Transactions
Reported Cause		
Normal Wear and Tear	82	329
Manufacturer Defects	2	6
Lack of Training	1	3
Abnormal Environment	1	5
Other and Unknown	14	55
Action Taken		
Completed with Parts	78	311
Completed (No Parts)	4	15
Cancelled	1	2
Other and Unknown	17	70

Table 3-5. MDS SUMMARY OF DEFERRED JCNs FOR CG-16 AND CG-26 CLASS AN/URT-23 ( ) TRANSMITTERS

Data Item	Percentage of Total Deferred JCNs	Number of Transactions
Deferral Reason		
Lack of Materials	78	81
Lack of Facilities	13	13
Work Backlog/Priority	9	9
Inadequate Training	-	-
Other and Unknown	-	-
Type Availability		
Depot	13	13
IMA	1	1
Ship's Force	80	83
Unknown	6	6

Deferred JCNs = 103 (20% of Total JCNs).

Table 3-6. AN/URT-23( ) TRANSMITTER SIGNIFICANT PARTS USAGE

Nomenclature	Module NSNs	Equipments/ Parts Used In	Parts Used		Average Part Operating Years		Parts Population		Annual Usage Rate		Best Replacement Factor Experienced (BRF_e)		Best Replacement Factor Fleet (BRF)
			CG-16	CG-26	CG-16	CG-26	CG-16	CG-26	CG-16	CG-26	CG-16	CG-26	
Frequency Standard	4G 6225-078-4718	AN/URT-23	15	13	3.0	4.3	19	14	5	3.02	0.26	0.22	0.3599
Translator/ Syntnesizer	4G 5820-167-7673	AN/URT-23	21	50	3.0	4.3	19	14	7	11.6	0.37	0.83	0.5599
	4G 5820-168-9560	AN/URT-23	4	-	3.0	-	19	-	1.3	-	0.07	-	0.6999
	4G 5820-879-7577	AN/URT-23	-	3	-	4.3	-	14	-	0.7	-	0.05	0.46
RF Amplifier Module	4G 5820-078-4721	AN/URT-23	6	3	3.0	4.3	19	14	2	0.7	0.11	0.05	0.5799
	4G 5820-167-7675	AN/URT-23	22	38	3.0	4.3	19	14	7.3	8.8	0.38	0.63	0.24
	4G 5820-168-9559	AN/URT-23	5	3	3.0	4.3	19	14	1.7	0.7	0.09	0.05	0.06
Final Transformer	4G 5820-836-2985	AN/URT-23	22	22	3.0	4.3	19	14	7.3	5.1	0.38	0.36	0.23

amplifier modules on both classes has decreased significantly, because of design improvements, the RF amplifier module is not expected to have excessive usage during the EOC.

The third item to display higher than normal usage (BRF_e exceeded BRF) was the final transformer. Twenty-two were used on each ship class during the data period. This translates into 0.38 transformers per equipment per operating year for the CG-26 Class. The fleet usage rate was 0.23 per equipment per operating year. One ship (CG-16) used 91 percent (20 of 22) of the final transformers, six of which were within a period of one month. One ship in the CG-26 Class (CG-32) used 64 percent (14 of 22), seven of which were within a period of one month. Therefore, it is concluded that the higher than normal parts usage for selected items of the AN/URT-23( ) transmitter on the CG-16 and CG-26 Class ships was a result of unusual occurrences and did not represent a class problem.

The CG-16 Class reported 35 total CASREPs, of which 66 percent were reported by one ship (CG-16); and the CG-26 Class reported seven CASREPs, of which all were reported by one ship (CG-32). The CASREP total supply downtime was 64.5 percent of the total CASREP downtime for the CG-16 Class and 74.1 percent of the total CASREP downtime for the CG-26 Class. CASREP narrative data indicated that the majority of CASREPs were caused by part failures to the RF amplifier, PA tubes, power supply, and diode assemblies. The average number of CASREPs per equipment operating year was 0.6 and 0.1 for the CG-16 and CG-26 Class ships, respectively. If the data for the CG-16 were excluded, the CASREPs per equipment operating year would decrease to 0.2. This rate of CASREPs per equipment operating year is not considered unusual or excessive. Therefore, it is concluded that parts support has been adequate; the ship's force has accomplished most repairs without outside assistance; and, because of the number of transmitters on board (6), the failure of one would not affect fleet capability.

3.2.5 Depot Repair Requirements

A review of the MDS narratives indicated six depot maintenance actions (JCNs) for the CG-16 Class and seven for the CG-26 Class ships. All six depot actions for the CG-16 Class were reported by one ship (CG-16), and all seven of the depot actions for the CG-26 Class were reported by one ship (CG-32). Five of the depot actions for the CG-16 Class were for rewiring worn connectors, and the sixth was a request for a matrix bypass. The seven depot actions reported by the CG-32 requested class B overhauls for the AN/URT-23( ) transmitters. Further investigation revealed that the CG-32 represented nearly 50 percent of the AN/URT-23( ) transmitters installed on the CG-26 Class ships during the data period.

Two of nine SARPs reviewed indicated that a class B overhaul was planned for the AN/URT-23( ) transmitters, to be accomplished at the depot level.

A review of the CG-16 and CG-26 Class ships repair requirements for BOH indicated a requirement for a class B overhaul to the AN/URT-23( ) transmitters. However, because of the relatively low corrective maintenance

burden (24 average man-hours per equipment operating year) and the submission of only 0.2 CASREPs per equipment operating year, class C repairs (as required by POT&I and CSMP results) are recommended for accomplishment at BOH and follow-on ROH. Therefore, it is recommended that the requirement for a class B overhaul be deleted from the DDEOC BOH repair requirements.

3.2.6 Maintenance Strategy

A review of the maintenance index pages (MIPs) for the AN/URT-23( ) transmitter did not reveal any maintenance requirements that would ordinarily require an outside activity for accomplishment. The DMS requirements for the AN/URT-23( ) transmitter are considered adequate.

Therefore, it is concluded that the AN/URT-23( ) transmitter can be kept operational during an extended operating cycle if a run-to-failure maintenance strategy is adopted, the present PMS requirements are accomplished, and the equipment receives class C repairs as required by POT&I and CSMP at BOH and follow-on ROH.

3.2.7 Recommendations

On the basis of the results of this analysis, the following recommendations are made for the CG-16 and CG-26 Class AN/URT-23( ) transmitters:

- Accomplish class C repairs of the AN/URT-23( ) transmitter at BOH as required by POT&I and CSMP.
- Include a qualified task in the class maintenance plan for class C repairs as required by POT&I and CSMP on the AN/URT-23( ) transmitters at ROH.

3.3 R-1051( )/URR RECEIVER (SWAB 441-4)

3.3.1 Background

The R-1051( )/URR receiver provides reception of single sideboard (SSB) and frequency shift keying (FSK) in the 2 to 30 MHz range.

The CG-16 and CG-26 Class ships have each carried an average of 12 R-1051( )/URR receivers throughout the MDS data period examined. Present plans also indicate that each CG-16 and CG-26 Class ship will have a typical quantity of 12 R-1051( )/URR receivers after BOH.

3.3.2 Discussion

The R-1051( )/URR receivers installed on board the CG-16 and CG-26 Class ships during the MDS data period examined consisted of three models (see table 3-7).

Table 3-7. R-1051( )/URR RECEIVERS FOR CG-16 AND CG-26 CLASS SHIPS			
Nomenclature	APL	Quantity, CG-16 Class	Quantity, CG-26 Class
R-1051/URR	81095100	6	67
R-1051B/URR	81095102	98	44
R-1051D/URR	81101551	8	0

Table 3-7 shows that the majority (88 percent) of the CG-16 Class HF receivers were the R-1051B/URR receivers. This table also shows that the majority (61 percent) of the CG-26 Class HF receivers were R-1051/URR receivers.

The three models shown in table 3-7 are similar in capability and differ primarily in manufacturer. These three models are examined individually to identify any differences in their maintenance experiences and to identify possible differences between ship classes. These models are grouped and discussed together only when the maintenance experiences are similar.

3.3.3 Man-Hour Summary

Table 3-8 summarizes the corrective maintenance man-hours reported during the MDS data period for the CG-16 and CG-26 Class R-1051( )/URR receivers.

Table 3-8. MAN-HOUR BURDEN SUMMARY FOR CG-16 AND CG-26 CLASS R-1051( )/URR RECEIVERS					
Equipment	APL	Population	Ship Class	Total Man-Hours	Average CM Man-Hours per Equipment Operating Year
R-1051/URR	81095100	6	16	389	11.1
R-1051B/URR	81095102	98	16	3,580	6.3
R-1051D/URR	81101551	8	16	70	1.5
R-1051/URR	81095100	67	26	4,378	9.7
R-1051B/URR	81095102	44	26	1,483	5.0

The data shown in table 3-8 indicate that the corrective maintenance experience was similar for the common R-1051( )/URR receivers of both the CG-16 and CG-26 Class ships. This table also shows that the R-1051/URR receivers required approximately twice as many corrective maintenance man-hours as the R-1051B/URR receivers of both the CG-16 and CG-26 Class ships. These differences are examined in subsections 3.3.4 and 3.3.5.

3.3.4 Maintenance Profile

The available MDS data were examined to identify possible differences in the corrective maintenance practices for the R-1051 and R-1051B/URR receivers. The data were also examined to determine what HF receiver maintenance has historically been accomplished by ship's force and outside activities and the major reasons for unscheduled maintenance.

Before this examination, the MDS data were first grouped by equipment model. The groups were then divided into subgroups by ship class. These subgroups (CG-16 Class R-1051/URR receivers, CG-26 Class R-1051/URR receivers, CG-16 Class R-1051B/URR receivers, CG-26 Class R-1051B/URR receivers, and CG-16 Class R-1051D/URR receivers) were each examined and compared with one another. This initial examination indicated that there was a negligible difference between the CG-16 and CG-26 Class corrective maintenance experienced by either the R-1051/URR receivers or the R-1051B/URR receivers; i.e., ship class did not affect the R-1051( )/URR receiver corrective maintenance experience. Therefore, the CG-16 and CG-26 Class MDS data for each model of the R-1051( )/URR receiver are combined and presented in summary form in tables 3-9 through 3-14. (The R-1051D/URR receiver data are not presented in these tables because of a lack of reported maintenance data.) These tables show in detail those data items which were judged to be significant. All data items that contributed little to the total equipment corrective maintenance burden or were reported in categories such as "not applicable" or "other" were grouped as "other". All data items that were not completed (not reported) during the MDS data period examined were grouped as "unknown".

The following findings are derived from the data presented in tables 3-9 through 3-14:

- Maintenance actions usually required less than 10 ship's force man-hours.
- A majority of the maintenance actions required parts replacement.
- Normal wear and tear was the major cause for maintenance actions.
- Maintenance action deferrals were usually the result of a lack of materials.
- No maintenance action deferrals resulted from a lack of training.
- Few IMA maintenance actions were required for ship's force support.
- Ship's force has corrected the majority of deferrals.

Table 3-9. MAN-HOUR SUMMARY FOR CG-16 AND CG-26 CLASS R-1051/URR RECEIVER

JCN Type	Man-Hour Distribution		Number of Transactions
	Range of Man-Hours	Percentage of Total JCNs with Man-Hours	
Ship's	0 - 10	92.0	786
Force	11 - 30	5.9	51
JCNs	31 or more	1.9	17
IMA	0 - 10	1.2	10
JCNs	11 or more	1.4	12

Total JCNs = 1,065.
Parts-only transactions = 211 (19.8%) of total JCNs.
Transactions with reported man-hours = 854 (80.2%) of total JCNs.
Both ship's force and IMA man-hours may be reported on a particular JCN.

Table 3-10. MDS SUMMARY OF DEFERRED JCNs FOR CG-16 AND CG-26 CLASS R-1051/URR RECEIVER

Data Item	Percentage of Total Deferred JCNs	Number of Transactions
Deferral Reason		
Lack of Materials	57.5	206
Lack of Facilities	13.7	49
Work Backlog/Priority	15.4	55
Inadequate Training	--	0
Other and Unknown	13.4	48
Type Availability		
Depot	8.7	31
IMA	4.7	17
Ship's Force	86.3	309
Unknown	0.3	1

Deferred JCNs = 358 (33.6% of total JCNs).

Table 3-11. MDS SUMMARY OF JCN CAUSE AND ACTION TAKEN CODES FOR CG-16 AND CG-26 CLASS R-1051/URR RECEIVER

Data Item	Percentage of Total JCNs with Reported Man-Hours	Number of Transactions
Reported Cause		
Normal Wear and Tear	77.9	666
Manufacturer Defects	0.5	4
Lack of Training	1.8	15
Abnormal Environment	0.7	6
Other and Unknown	19.1	163
Action Taken		
Completed with Parts	78.6	671
Completed (No Parts)	6.8	58
Cancelled	6.3	54
Other and Unknown	8.3	71

Table 3-12. MAN-HOUR SUMMARY FOR CG-16 AND CG-26 CLASS R-1051B/URR RECEIVER

JCN Type	Man-Hour Distribution		Number of Transactions
	Range of Man-Hours	Percentage of Total JCNs with Man-Hours	
Ship's Force JCNs	0 - 10	92.6	717
	11 - 30	4.7	36
	31 or more	2.7	21
IMA JCNs	0-10	1.8	13
	11 or more	0.5	4

Total JCNs = 1,056.
Parts-only transactions = 282 (26.7%) of total JCNs.
Transactions with reported man-hours = 774 (73.3%) of total JCNs.
Both ship's force and IMA man-hours may be reported on a particular JCN.

Table 3-13. MDS SUMMARY OF DEFERRED JCNs FOR CG-16 AND CG-26 CLASS R-1051B/URR RECEIVER

Data Item	Percentage of Total Deferred JCNs	Number of Transactions
Deferral Reason		
Lack of Materials	52.2	141
Lack of Facilities	4.4	12
Work Backlog/Priority	32.6	88
Inadequate Training	--	0
Other and Unknown	10.7	29
Type Availability		
Depot	2.9	8
IMA	1.5	4
Ship's Force	92.6	250
Unknown	2.9	8

Deferred JCNs = 270 (25.6% of total JCNs).

Table 3-14. MDS SUMMARY OF JCN CAUSE AND ACTION TAKEN CODES FOR CG-16 AND CG-26 CLASS R-1051B/URR RECEIVER

Data Item	Percentage of Total JCNs with Reported Man-Hours	Number of Transactions
Reported Cause		
Normal Wear and Tear	74.5	577
Manufacturer Defects	1.8	14
Lack of Training	1.9	15
Abnormal Environment	1.4	11
Other and Unknown	20.3	157
Action Taken		
Completed with Parts	81.5	631
Completed (No Parts)	5.4	42
Cancelled	2.3	18
Other and Unknown	10.7	83

It is evident from the data presented in tables 3-9 through 3-14 that the corrective maintenance experience for the R-1051/URR receivers is similar to that of the R-1051B/URR receivers. That is, similar types of corrective maintenance actions are being accomplished on the R-1051 and R-1051B/URR receivers. It can also be concluded from this MDS data summary that ship's force personnel, with minimal outside assistance, are capable of performing the majority of the maintenance actions required to keep the R-1051( )/URR receivers operational.

3.3.5 Parts Usage

The available MDS parts usage data were examined to identify those R-1051( )/URR receiver parts with significant usage rates. The significant CG-16 and CG-26 Class R-1051( )/URR receiver parts are summarized in table 3-15. This table also shows the reported parts usage for parts that can be substituted for parts identified as significant (see table 3-15).

When the computed "experienced" best replacement factors, BRF_e, were compared with the available BRF data published by ships parts control center (SPCC) in the master best replacement factor list, it was evident that the CG-16 and CG-26 Class R-1051( )/URR receiver usage rates for significant parts were usually better than (lower than) that experienced by the fleet. Only one significant part experienced a higher usage rate than the fleet average (see table 3-15, Translator/Synthesizer, NSN 4G 5820-00-078-4720).

Discussions with NAVELEX (equipment design and acquisitions branch - 5101) and SPCC (item manager for WRC-1 family) technical personnel indicated that the Navy community is already aware of the low reliability of this module and has taken steps to correct the situation. Eight hundred fifty-three new translator/synthesizer modules have been purchased, and another 853 modules are being purchased. A translator/synthesizer module modification kit has also been developed, and approximately 250 modules will be modified in the near future. These actions already taken by the Navy technical community are expected to increase the translator/synthesizer availability and increase the module reliability. Therefore, no further actions are recommended at this time.

Man-Hour Verification

Further examination of the significant R-1051( )/URR parts usage indicated that the R-1051/URR receiver has historically required more parts than the R-1051B/URR receiver. Table 3-16 compares the experienced usage rates (BRF_e) of the R-1051/URR BRF_e with the R-1051B/URR BRF_e. This ratio shows that the number of significant part replacements required for the R-1051/URR receivers was 2 to 10 times the number of similar significant part replacements required for the R-1051B/URR receivers (see table 3-16).

This parts usage difference, when considered with the findings of subsection 3.3.4 (similar types of corrective maintenance actions are being accomplished on the R-1051 and R-1051B/URR receivers), indicates that

Table 3-15. R-1051( )/URR RECEIVER SIGNIFICANT PARTS USAGE

Nomenclature	Module NSNs	Equipments/ Parts Used in	Parts Used		Average Part Operating Years		Part Population		Annual Usage Rate		BRF Experienced		BRF (Fleet)
			CG-16	CG-26	CG-16	CG-26	CG-16	CG-26	CG-16	CG-26	CG-16	CG-26	
Frequency Standard	4G 6225-00-078-4718	R-1051B/URR	111	39	5.8	6.7	98	44	19.14	5.82	0.19	0.13	0.3599
		R-1051/URR	7	118	5.8	6.7	6	67	1.21	17.61	0.20	0.26	0.3599
	4G 6225-00-160-0623	R-1051B/URR	1	3	5.8	6.7	98	44	0.17	0.45	0.001	0.002	0.3099
		R-1051/URR	-	1	5.8	6.7	6	67	-	0.15	-	0.002	0.3099
Translator/Synthesizer	4G 5820-00-078-4720	R-1051B/URR	25	38	5.8	6.7	98	44	4.31	5.67	0.04	0.13	0.5599
		R-1051/URR	14	305	5.8	6.7	6	67	2.41	45.52	0.40	0.67	0.5599
	4G 5820-00-167-7673	R-1051B/URR	180	28	5.8	6.7	98	44	31.03	4.18	0.31	0.04	1.19
		R-1051/URR	3	41	5.8	6.7	6	67	0.52	6.12	0.08	0.09	1.19
	4G 5820-00-168-9560	R-1051B/URR	3	1	5.8	6.7	98	44	0.52	0.15	0.01	0.003	0.6999
		R-1051/URR	-	5	5.8	6.7	6	67	-	0.75	-	0.01	0.6999
	4G 5820-00-879-7577	R-1051B/URR	31	16	5.8	6.7	98	44	5.34	2.39	0.07	0.05	0.46
		R-1051/URR	-	22	5.8	6.7	6	67	-	3.28	-	0.05	0.46
RF Amplifier Mode	4G 5820-00-078-4721	R-1051B/URR	66	35	5.8	6.7	98	44	11.38	5.22	0.11	0.12	0.5799
		R-1051/URR	2	143	5.8	6.7	6	67	0.34	21.34	0.06	0.31	0.5799
	4G 5820-00-167-7675	R-1051B/URR	85	13	5.8	6.7	98	44	14.66	1.94	0.15	0.04	0.24
		R-1051/URR	8	72	5.8	6.7	6	67	1.38	10.75	0.22	0.16	0.24
	4G 5820-00-168-9559	R-1051B/URR	6	2	5.8	6.7	98	44	1.03	0.29	0.01	0.006	0.06
		R-1051/URR	-	1	5.8	6.7	6	67	-	0.15	-	0.0002	0.06
Receiver Mode Selection	4G 5820-00-078-4723	R-1051B/URR	14	14	5.8	6.7	98	44	2.41	2.09	0.02	0.05	0.053
		R-1051/URR	6	22	5.8	6.7	6	67	1.03	3.28	0.17	0.05	0.053
Receiver IF Amplifier	4G 5820-00-078-4725	R-1051B/URR	52	25	5.8	6.7	98	44	8.97	3.73	0.09	0.09	0.10
		R-1051/URR	8	108	5.8	6.7	6	67	1.38	16.12	0.23	0.24	0.10

Table 3-16. R-1051/URR AND R-1051B/URR RECEIVER PARTS USAGE (CG-16 AND CG-26 CLASSES)				
NSN	BRF_e R-1051	BRF_e R-1051B	Ship Class	$\frac{BRF_e \text{ R-1051}}{BRF_e \text{ R-1051B}}$
4G 6625-078-4718	0.26	0.13	26	2.0
4G 5820-078-4720	0.67	0.13	26	5.1
4G 5820-078-4721	0.31	0.12	26	2.6
4G 5820-167-7675	0.16	0.04	26	4.0
4G 5820-078-4725	0.24	0.09	26	2.7
4G 5820-078-4720	0.40	0.04	16	10.0
4G 5820-167-4723	0.17	0.05	16	3.4
4G 5820-167-4725	0.23	0.09	16	2.6

the R-1051B/URR receiver is more reliable than the R-1051/URR receiver. That is, the corrective maintenance requirements for the R-1051 and the R-1051B/URR receivers are similar, but the R-1051/URR receiver requires *more corrective maintenance* than the R-1051B/URR receivers. This explains why the average corrective maintenance man-hours per equipment operating year for these two receivers were different (see subsection 3.3.3).

CASREP Review

A review of the CASREPs reported against the R-1051( )/URR receivers indicated that the CASREP submission rate for each ship class and for each receiver model was not excessive. This review also indicated that the CASREP submission rate was approximately 1.6 times higher for the R-1051/URR receiver than for the R-1051B/URR receiver. Table 3-17 presents a CASREP submission summary for the CG-16 and CG-26 Class R-1051( )/URR receivers.

Table 3-17. CASREP SUBMISSION RATE SUMMARY FOR CG-16 AND CG-26 CLASS R-1051( )/URR RECEIVERS

Nomenclature APL	CG-16 Class			CG-26 Class			Total Equipment Operating Years (CG-16 and CG-26 Class)	Total CASREPs per Total Equipment Operating Years (CG-16 and CG-26 Class)
	CASREPs Submitted	Equipment Operating Years	CASREPs per Equipment Operating Year	CASREPs Submitted	Equipment Operating Years	CASREPs per Equipment Operating Year		
R-1051/URR Receiver 81095100	8	314.4	0.025	40	4046.8	0.009	4361.2	0.011
R-1051B/URR Receiver 81095102	44	5135.2	0.009	10	2657.6	0.038	7792.8	0.007

The data presented in table 3-17 show that the CG-16 Class ships reported R-1051/URR CASREPs at a higher rate than R-1051B/URR CASREPs. These data also show that the CG-26 Class ships reported R-1051B/URR CASREPs at a higher rate than R-1051/URR CASREPs (see table 3-17). Further examination showed that those CG-16 and CG-26 Class ships which carried a majority of one model of R-1051( )/URR receivers and a small number of the other models were the ships that experienced the "problems" (increased CASREP rate and parts usage) with the receivers that were in the minority. This inconsistency occurs because the technicians will sometimes substitute parts in a receiver that either should not have been used or should have been modified before the substitution. This happens because the modules for the different models of R-1051( )/URR receivers are physically the same. For example, the 100 Hz tuned translator/synthesizer for the R-1051B/URR receiver, NSN 4G 5820-00-879-7577, should never be substituted for a 500 Hz tuned translator/synthesizer for the R-1051/URR receiver, NSN 4G 5820-00-078-4720, or vice versa. Yet, a review of the MDS parts usage data indicated that six CG-26 Class ships placed 22 B-model translator/synthesizers into R-1051/URR receivers, and that seven CG-26 Class ships placed 38 R-1051/URR translator/synthesizers into R-1051B/URR receivers.

Discussions with NAVELEX 5101 technical personnel also indicated that R-1051( )/URR receivers are often found with incorrect modules installed.

Discussions with the SPCC item manager for the AN/WRC-1 family of equipments indicated that a NAVELEX instruction is available to ship's force personnel with relevant R-1051( )/URR receiver parts replacement information. NAVELEXINST P4110.45, the integrated logistics support plan for the AN/SRC-1 family of equipments, dated April 1975, identifies those modules that can be used in more than one model of R-1051( )/URR receiver, those modules that must be adjusted before being used in particular models of receivers, and those modules that are applicable only to one model of R-1051( )/URR receiver. It is evident from the MDS parts usage data that ship's force personnel either do not have this instruction or are not using it. Therefore, it is recommended that ship's force personnel adhere strictly to this instruction in the future.

This problem could be eliminated by a design change to the R-1051/URR receiver that would not allow B-, D-, or E-model translator/synthesizers to fit in an R-1051/URR receiver. However, this solution would be costly and time-consuming. A cheaper and less time-consuming solution is to label the different R-1051( )/URR receivers and the respective modules with permanent warning labels that are easily seen so that technicians could not inadvertently substitute incorrect modules. These labels should show both model type and module substitution applicability. Therefore, it is recommended that the R-1051( )/URR receivers and modules be permanently labeled with warning labels to show model type and module substitution applicability.

The module most often ordered under CASREP was the translator/synthesizer. A total of 87 translator/synthesizers were ordered on 102 CASREPs. The availability and reliability of this part are not expected to present problems during the DDEOC intracycle because the Navy technical

community has purchased more translator/synthesizers and is modifying these modules as previously discussed in this section. Future correct module replacements will also further decrease corrective maintenance burden, now caused by the translator/synthesizers.

No other single part was ordered on a significant number of total R-1051( )/URR receiver CASREPs. It was also evident after review of the available CASREPs that ship's force was usually able to correctly diagnose operational problems with the R-1051( )/URR receivers and to accomplish those repairs if the parts were available. The small CASREP rate for the R-1051( )/URR receivers also indicates that supply support is adequate.

3.3.6 Intracycle Maintenance Strategy

Ship's force personnel, with minimal outside assistance, are capable of performing the majority of the corrective maintenance actions required to keep the R-1051( )/URR receivers operational, as discussed in subsection 3.3.4.

MRC Review

A review of the maintenance index pages (MIPs) for the R-1051( )/URR receivers did not reveal any maintenance requirements that would ordinarily necessitate the help of an outside activity. The PMS requirements for the R-1051( )/URR receivers are considered adequate.

IMA Maintenance

The narratives for those 21 maintenance actions (CG-16 Class, 2 JCNs; CG-26 Class, 19 JCNs) which reported IMA assistance were reviewed. Generally, these transactions were minor and nonrepetitive. No evidence was found that would indicate that planned IMA assistance would benefit the CG-16 or CG-26 Class ships during the DDEOC intracycle. Typical IMA maintenance actions were requests for the IMA to align and calibrate the R-1051( )/URR receivers and electronic test equipment, improve receiver mountings, and install new units received by the ships.

Intracycle Maintenance

The existing maintenance strategy of performing the preventive maintenance prescribed by PMS and "run to failure" is considered adequate to support the R-1051( )/URR receiver through an extended operating cycle for the following reasons:

- The historical average corrective maintenance man-hours per equipment operating year was minimal [table 3-12 shows that the worst case produced 11.1 man-hours per equipment operating year (EOY)].
- Supply support for the R-1051( )/URR receiver is adequate and is expected to improve in the near future (see subsection 3.3.5).

- Ship's force personnel can adequately diagnose operational problems and repair the R-1051( )/URR receivers with limited outside assistance (see subsections 3.3.4 and 3.3.5).

3.3.7 Depot Repair Requirements

MDS Narrative Review

The MDS narratives for those R-1051( )/URR receiver transactions which reported depot assistance were reviewed. This review of these 39 transactions (CG-16 Class, 4 JCNs; CG-26 Class, 35 JCNs) did not identify any depot level transactions that were unique to either ship class or a particular model of R-1051( )/URR receiver. Approximately half of these requests were for class B overhaul (21 JCNs). The remaining depot level transactions were generally nonrepetitive and minor.

SARP Review

Five of six SARPs reviewed indicated that quantities of R-1051( )/URR receivers that varied from 1 to 12 received a class B overhaul during past shipyard availabilities. This task was usually completed by ship's force personnel (four of five SARPs), and each receiver took an average of eight man-days to overhaul.

Approximately half of the R-1051( )/URR receivers installed received a class B overhaul by ship's force, as reported by the SARPs. The remaining R-1051( )/URR receivers usually received class C repairs by ship's force if any repairs were accomplished at all.

Depot Recommendations

The CG-16 and CG-26 Class SARP review indicated that approximately half of the R-1051( )/URR receivers have received class B overhauls during shipyard availabilities. The MDS data review indicated that the same types of corrective maintenance actions were being performed on all R-1051( )/URR receivers during the intracycle. It can be concluded from these facts that past shipyard availabilities produced no quantitative effects on R-1051( )/URR receiver corrective maintenance practices; i.e., HF receivers that were class B overhauled experienced the same intracycle corrective maintenance actions as the HF receivers that received class C repairs during overhauls. Therefore, since there is not sufficient evidence to justify class B overhauls for the R-1051( )/URR receivers during overhauls, it is recommended that all R-1051( )/URR receivers have class C repairs accomplished by ship's force during BOH and subsequent ROHs. It is also recommended that ship's force personnel be provided with sufficient guidance so that strict adherence to NAVELEX Instruction P4110.45, the integrated logistics support plan for the AN/WRC-1 family, dated April 1975, is exercised while these overhauls are being performed (see subsection 3.3.5).

This recommendation does not agree with present CG-16 or CG-26 Class repair requirements for BOH. Both documents recommend a class B overhaul for the R-1051( )/URR receivers. On the basis of the findings of this analysis, it is recommended that the present CG-16 and CG-26 Class repair

requirements for BOH line items for class B overhaul of the R-1051( )/URR receivers be deleted.

3.3.8 Recommendations

This subsection presents the recommended maintenance policy and specific recommendations for the extended operating cycle resulting from the analysis of the R-1051( )/URR receiver.

The existing maintenance strategy of performing the preventive maintenance prescribed by PMS and "run to failure" is adequate to support the R-1051( )/URR receiver through an extended operating cycle. The recommendations are as follows:

- BOH Requirements - Accomplish class C repairs of the R-1051( )/URR receivers by ship's force for all CG-16 and CG-26 Class ships. Note: ship's force personnel are to adhere strictly to NAVELEXINST P4110.45, the integrated logistics support plan for the AN/WRC-1 family, dated April 1975, while accomplishing this overhaul. Note: this recommendation does not agree with the present CG-16 or CG-26 Class repair requirements for BOH. On the basis of the findings of this analysis, it is recommended that the present line items of the CG-16 and CG-26 Class repair requirements for BOH specifying class B overhaul of the R-1051( )/URR receiver be deleted.
- Follow-On ROH Requirements - Include a qualified task in the CG-16 and CG-26 Class CMPs for ship's force to accomplish class C repairs to the R-1051( )/URR receivers. Note: ship's force personnel are to exercise strict adherence to NAVELEXINST P4110.45, the integrated logistics support plan for the AN/WRC-1 family, dated April 1975, while accomplishing the overhaul.
- Recommended Reliability and Maintainability Improvements - Label the different R-1051( )/URR receivers and the respective modules with warning labels that show model type and module substitution applicability.

3.4 R-390A/URR RECEIVER (SWAB 441-4)

3.4.1 Background

The R-390A/URR receiver is being superseded by the R-1051( )/URR receiver, discussed in section 3.3. However, a quantity of one R-390A receiver will be retained on board each CG-16 and CG-26 Class ship in accordance with shipalts CG-16-1057 and CG-26-0377 because the R-390A receiver has a broader frequency range than the R-1051( )/URR receivers. Both the CG-16 and the CG-26 Class ships are scheduled to have their applicable shipalt accomplished during BOH. Therefore, each CG-16 and CG-26 Class ship will have one R-390A receiver after BOH.

Sixteen R-309A receivers were installed on CG-16 Class ships and 64 R-390A receivers were installed on CG-26 Class ships during the MDS data period examined. Although the receiver distribution was not uniform among the ships of each ship class, each CG-16 Class ship had at least one R-390A receiver and the typical CG-26 Class ship carried six of these receivers.

3.4.2 Corrective Maintenance Experience

The available maintenance data were examined to determine what R-390A receiver maintenance has historically been accomplished by ship's force and other outside organizations, and to determine the major reasons for unscheduled maintenance.

MDS Data Summary

The available MDS data are summarized in tables 3-18 through 3-20. For ease of presentation and discussion, the CG-16 and CG-26 Class data were combined since the pattern of maintenance was the same. The following findings are taken from tables 3-18 through 3-20:

- Approximately 79 percent of the R-390A receiver JCNs with reported man-hours were completed by ship's force in 10 man-hours or less.
- IMA transactions constituted approximately four percent of the R-390A receiver JCNs requiring maintenance.
- Normal wear and tear was the reported cause of approximately 70 percent of the R-390A receiver JCNs with reported man-hours.
- Approximately 71 percent of the R-390A receiver transactions with reported man-hours required supply parts for completion.
- Approximately 39 percent of the CG-16 and CG-26 Class R-390A receiver deferred JCNs were the result of lack of materials (parts). This represents only 15 percent of the total JCNs.
- Approximately 70 percent of the R-390A receiver deferred JCNs were corrected by ship's force.

It is concluded from this MDS data summary that ship's force personnel, with limited outside assistance, are capable of performing most of the corrective maintenance actions to keep the R-390A receiver operational, if the required parts are available.

Parts Usage

A review of the MDS parts usage data for the R-390A receiver indicated that no single nonconsumable part had an average time between replacements of less than 2.6 ship operating years. If it is assumed that on-board spares can be restocked in one year or less, then parts availability should not present a problem to the R-390A receiver during an extended operating cycle.

Table 3-18. MAN-HOUR SUMMARY FOR CG-16 AND CG-26 CLASS R-390A/URR RECEIVER

JCN Type	Man-Hour Distribution		Number of Transactions
	Range of Man-Hours	Percentage of Total JCNs with Man-Hours	
Ship's Force JCNs	0 - 10	79	291
	11 - 30	16	57
	31 or more	5	19
IMA JCNs	0 - 10	4	14
	11 or more	4	16

Transactions with reported man-hours = 367 (69%) of total JCNs.
Both ship's force and IMA man-hours may be reported on a particular JCN.

Table 3-19. MDS SUMMARY OF JCN CAUSE AND ACTION TAKEN CODES FOR CG-16 AND CG-26 CLASS R-390A/URR RECEIVERS

Data Item	Percentage of Total JCNs with Man-Hours	Number of Transactions
Reported Cause		
Normal Wear and Tear	70	259
Manufacturer Defects	1	2
Lack of Training	5	17
Abnormal Environment	1	5
Other and Unknown	23	84
Action Taken		
Completed with Parts	71	261
Completed (No Parts)	13	46
Cancelled	-	-
Other and Unknown	16	60

Table 3-20. MDS SUMMARY OF DEFERRED JCNs FOR CG-16 AND CG-26 CLASS R-390A/URR RECEIVER

Data Item	Percentage Total of Deferred JCNs	Number of Transactions
Deferral Reason		
Lack of Materials	39	80
Lack of Facilities	15	32
Work Backlog/Priority	30	62
Inadequate Training	1	2
Other and Unknown	15	31
Type Availability		
Depot	9	18
IMA	7	14
Ship's Force	70	146
Unknown	14	29

Deferred JCNs = 207 (39% of total JCNs).

CASREP Review

No R-390A receiver CASREPs were reported by the CG-16 Class ships and only three CASREPs were reported by the CG-26 Class ships. Subsequently, CASREP review did not reveal any part availability problems or significant downtime.

Man-Hour Burden Summary

A man-hour burden summary for the CG-16 and CG-26 Class R-390A receivers is presented in table 3-21. These data show that the average man-hour burdens experienced by the ship classes were very similar (see table 3-20).

Table 3-21. MAN-HOUR BURDEN SUMMARY FOR THE CG-16 AND CG-26 CLASS R-390A/URR RECEIVERS

Ship Class	Population	Number of Ships	Total Ship Operating Years	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Average Corrective Maintenance Man-Hours per Equipment Operating Year
CG-16	16	9	52.2	566	114	680	7.3
CG-26	64	9	66.4	2,536	556	3,092	7.2

This low corrective maintenance man-hour rate is expected to continue through the DDEOC intracycle since no significant failure modes, parts reliability, or parts availability problems have been identified. Therefore, major restorative maintenance for the R-390A receiver is not expected to be required during the DDEOC intracycle.

3.4.3 Preventive Maintenance Review

A review of the applicable MIPs for the R-390A receiver did not identify any requirements that would normally require outside assistance. The present required PMS for the R-390A receiver was also judged to be adequate.

3.4.4 Extended Operating Cycle Maintenance

Intracycle Maintenance

It is evident from the findings presented in subsection 3.4.2 that the average R-390A receiver has historically required very little ship's force and IMA corrective maintenance and that ship's force is usually capable of performing those corrective maintenance actions needed to keep the R-390A receiver operational. Since no significant failure modes or parts reliability or availability problems could be identified, the low R-390A corrective maintenance burden is expected to continue during the DDEOC intracycle. Therefore, the present maintenance strategy of performing the preventive maintenance prescribed by PMS and "run-to-failure" is adequate to support the R-390A receiver through an extended operating cycle.

Depot Maintenance

A review of the available CG-16 and CG-26 Class SARPs showed that four of six ships accomplished class B overhauls to their R-390A receivers during shipyard availabilities. The remaining two ships effected class C repairs to their R-390A receivers.

The R-390A receivers have historically required little corrective maintenance (approximately seven man-hours per equipment operating year), and few CASREPs. This equipment has also required little outside support and demonstrated no significant parts problem. For these reasons, major restorative maintenance should not be required at BOH or ROH, or during the intracycle. Therefore, it is recommended that class C repairs (as required by POT&I and CSMP results) be accomplished at BOH and follow-on ROH.

This task is currently included in the CG-26 Class DDEOC repair requirements for BOH but not in the CG-16 Class DDEOC repair requirements for BOH. On the basis of this analysis, it is recommended that class B overhaul for the R-390A receiver be deleted from the CG-26 Class DDEOC repair requirements for BOH.

3.4.5 Recommendations

On the basis of this analysis, the following recommendations are made for the CG-16 and CG-26 Class R-390A receivers:

- BOH Recommendations - Accomplish class C repairs as required by POT&I and CSMP.
- Follow-on ROH Requirements - Include a qualified task in the CG-16 and CG-26 Class CMPs for ship's force to accomplish class C repairs to the R-390A receivers as required by POT&I and CSMP.

3.5 AN/SRA-22 AND AN/URA-38 ANTENNA COUPLER (SWAB 441-2)

3.5.1 Background

The antenna coupler group AN/SRA-22 on the CG-16 and CG-26 Class ships, which is supported by APL 57101400, is scheduled for removal in accordance with shipalt CG-16-1051 and CG-26-377 before or during BOH. The AN/SRA-22 antenna coupler group is being replaced with the AN/URA-38 antenna coupler group. Therefore, although the AN/URA-38 was not a selected item for analysis, it was analyzed in place of the AN/SRA-22 to determine the maintenance requirements for the EOC.

3.5.2 Discussion

The AN/URA-38 antenna coupler has been installed on five CG-16 Class ships (CG-16, -17, -18, -19, and -21) and two CG-26 Class ships (CG-28 and -32) within the past two years. However, the small quantity of reported

MDS maintenance data for the AN/URA-38 antenna coupler does not permit a qualitative analysis.

A review of the applicable MIPs for the AN/URA-38 antenna coupler indicated a cyclic requirement for overhaul in accordance with MIP C-389/1-66. This task is a recommended engineered input to the CMP to be accomplished at ROH. It is also recommended for accomplishment at BOH.

A review of the DDEOC repair requirements for BOH for the CG-16 and CG-26 Class ships indicated a requirement for a class B overhaul for the AN/SRA-22 and the AN/URA-38 antenna coupler groups. Since the AN/SRA-22 will be removed by BOH, it is recommended that the requirement for a class B overhaul be deleted from the DDEOC repair requirements.

3.5.3 Recommendations

The recommendations for the AN/SRA-22 and AN/URA-38 antenna coupler for the CG-16 and CG-26 Class ships are as follows:

- Baseline Overhaul Requirements
  - Accomplish class B overhaul to the AN/URA-38 antenna coupler in accordance with MIP C-389/1-66.
  - Delete the requirement for a class B overhaul for the AN/SRA-22 antenna coupler from the DDEOC repair requirements.
- Follow-On ROH Requirements - Include an engineered task in the CMP for a depot-level class B overhaul to the AN/URA-38 antenna coupler in accordance with MIP C-389/1-66.

3.6 AN/SRA-33 UHF ANTENNA COUPLER (SWAB 441-2)

3.6.1 Background

The AN/SRA-33 coupler is used to connect multiple radio transceivers to a single UHF antenna. The configuration for CG-16 and CG-26 Class ships varies, with some ships having only one AN/SRA-33 installed, while others have as many as four.

3.6.2 MDS Summary

The available MDS data were examined to identify possible differences in the corrective maintenance practices between the two ship classes, to determine what AN/SRA-33 antenna coupler maintenance has historically been accomplished by ship's force and outside activities, and to determine the major reasons for unscheduled maintenance.

Before this examination the available MDS data were separated by ship class. Each data group was then examined and compared with the other group. This initial examination indicated that there was a negligible difference between the CG-16 and CG-26 Class corrective maintenance experiences; i.e.,

ship class did not affect the AN/SRA-33 antenna coupler corrective maintenance experience. Therefore, the CG-16 and CG-26 Class MDS data for the AN/SRA antenna coupler are combined and presented in summary form in tables 3-22 through 3-24.

Tables 3-22 through 3-24 show in detail those data which were judged to be significant. All data items that contributed little to the total equipment corrective maintenance burden or were reported in categories such as "not applicable" or "other" were grouped as "other". All data items that were not completed or not reported during the MDS data period examined were grouped as "unknown".

The following findings are derived from the data presented in tables 3-22 through 3-24:

- Approximately 72 percent of all AN/SRA-33 antenna coupler transactions with reported man-hours required 10 or fewer ship's force man-hours.
- Approximately 59.5 percent of all AN/SRA-33 antenna coupler transactions with reported man-hours were the result of normal wear and tear.
- Approximately 57.1 percent of all AN/SRA-33 antenna coupler transactions with reported man-hours were completed with parts from supply.
- Approximately 46.9 percent of the total AN/SRA-33 JCNs were deferred.
- Approximately 40.2 percent of the deferred JCNs resulted from lack of facilities or capabilities.
- Ship's force personnel corrected approximately 50.5 percent of total deferred JCNs, and the depot completed approximately 28.9 percent of the total deferred JCNs.
- IMA assistance was required infrequently (8.2 percent of the total deferred JCNs were completed by an IMA).

It is evident from this MDS data summary that approximately one out of every seven AN/SRA-33 antenna coupler transactions was completed by the depot and that an unusual number of deferrals resulted from a lack of facilities or capabilities.

The MDS narratives were reviewed to determine what AN/SRA-33 antenna coupler repairs were being accomplished by the depot (what facilities or capabilities ship's force personnel lack) and to determine a frequency of repair.

Thirteen different ships had 39 deferrals resulting from "lack of facilities or capabilities". A total of 11 of these 39 deferrals were completed during regular shipyard availabilities. Eight of these 11 deferrals were requests for class B overhauls, two were requests to repair and align the AN/SRA-33 antenna coupler, and one was a request to install an antenna coupler.

Table 3-22. MAN-HOUR SUMMARY FOR CG-16 AND CG-26 CLASS AN/SRA-33 ANTENNA COUPLER

JCN Type	Man-Hour Distribution		Number of Transactions
	Range of Man-Hours	Percentage of Total JCNs with Reported Man-Hours	
Ship's Force JCNs	0 - 10	72.0	121
	11 -30	19.0	32
	31 or more	8.9	15
IMA JCNs	0 - 10	1.2	2
	11 or more	5.9	10

Total JCNs = 207.
Parts-only transactions = 39 (18.8%) of total JCNs.
Transactions with reported man-hours = 168 (81.2%) of total JCNs.
Both ship's force and IMA man-hours may be reported on a particular JCN.

Table 3-23. MDS SUMMARY OF DEFERRED JCNs FOR CG-16 AND CG-26 CLASS AN/SRA-33 ANTENNA COUPLER

Data Item	Percentage of Total Deferred JCNs	Number of Transactions
Deferral Reason		
Lack of Materials	27.8	27
Lack of Facilities	40.2	39
Work Backlog/Priority	13.4	13
Inadequate Training	1.0	1
Other and Unknown	17.5	17
Type Availability		
Depot	28.9	28
IMA	8.2	8
Ship's Force	50.5	49
Unknown	12.4	12

Deferred JCNs = 97 (46.9% of total JCNs).

Table 3-24. MDS SUMMARY OF JCN CAUSE AND ACTION TAKEN CODES FOR CG-16 AND CG-26 CLASS AN/SRA-33 ANTENNA COUPLER

Data Item	Percentage of Total JCNs with Reported Man-Hours	Number of Transactions
Reported Cause		
Normal Wear and Tear	59.5	100
Manufacturer Defects	1.8	3
Lack of Training	1.8	3
Abnormal Environment	1.8	3
Other and Unknown	35.1	59
Action Taken		
Completed with Parts	57.1	96
Completed (No Parts)	20.2	34
Cancelled	5.4	9
Other and Unknown	17.3	29

The 28 remaining deferrals resulting from "lack of facilities or capabilities" were all completed during the intracycle. Twenty-one of these deferrals were completed by the depot, and six were completed by the depot and an IMA, or an IMA. Eleven of these 28 deferrals indicated that a class B overhaul was required, and there were 14 requests to repair and align the antenna coupler. One request was to install an AN/SRC-33 antenna coupler, and two deferrals contained no narratives. These 28 transactions all occurred between two and 50 months after the individual ships had completed ROH, with the average amount of time being approximately 24 months after the completion of ROH.

The specific repairs made to the AN/SRA-33 antenna couplers during the 28 transactions previously described could not be determined from the MDS narratives.

3.6.3 MDS Parts Usage Review

A review of the parts usage for the CG-16 and CG-26 Class AN/SRA-33 antenna couplers did not indicate any significant repetitive part usage. Not one part experienced an average usage rate greater than one part every 2.6 years. Therefore, parts reliability is not expected to present a problem during the DDEOC intracycle.

3.6.4 CASREP Review

During the CG-16 and CG-26 Class CASREP data period, the CG-16 Class ships reported nine CASREPs with an average downtime of 25.7 days, and the CG-26 Class ships reported 10 CASREPs with an average downtime of 55.4 days. Eighteen of the 19 total CASREPs were due to part failures. One was due to a personnel error.

No single part was ordered on a majority of the AN/SRA-33 antenna coupler CASREPs. The part failures appeared to be random. Sixteen of the total 19 CASREPs ordered only one part or used no parts at all. Therefore, no specific part is expected to present an availability problem during the DDEOC intracycle.

Approximately 41 percent of the total CG-16 and CG-26 Class CASREP downtime was spent performing corrective maintenance or troubleshooting. Since few parts were actually replaced, it can be assumed that either part replacements are taking an unusual number of hours (approximately 264 hours per part -- total number of CASREP maintenance hours reported ÷ total number of CASREP parts ordered) or the troubleshooting processes are taking too many hours. Either case indicates that ship's force personnel are not adequately trained to maintain the AN/SRA-33 antenna coupler.

3.6.5 Training

Although more antenna coupler maintenance is needed in the electronic technician (ET) "A" schools, this addition to the present curriculum would not necessarily benefit the CG-16 and CG-26 Class ships in the immediate

future because these "new" ETs may or may not be assigned to CG-16 or CG-26 Class ships as their first sea duty tour. (See following section for recommendation.)

3.6.6 Intracycle Maintenance

The corrective maintenance experience during a DDEOC intracycle is expected to be similar to that experience shown by the MDS and CASREP data examined during this analysis. Historical data have shown that the number of ship's force corrective maintenance man-hours has sometimes been excessive. The amount of antenna coupler downtime is a direct result of the lack of ship's force personnel training. To effect a change that will benefit those CG-16 and CG-26 Class ships entering DDEOC, it is recommended that a qualified task be included in the CG-16 and CG-26 Class CMPs for the depot to accomplish class C repairs to the AN/SRA-33 antenna couplers as needed during SRA-1 and SRA-2. These availabilities are expected to occur approximately 20 to 40 months after BOH and subsequent ROHs. (The average amount of time after ROH that ships reported antenna coupler problems -- deferrals due to lack of capability -- was 24 months.)

It is also recommended that depot personnel train ship's force personnel to repair the antenna couplers during these SRAs. This process would train those technicians serving on CG-16 and CG-26 Class ships and would certainly reduce future troubleshooting and corrective maintenance man-hours for ship's force personnel.

3.6.7 BOH and ROH Maintenance

A review of the available CG-16 and CG-26 Class SARPs indicated that the AN/SRA-33 antenna couplers were a routine class B overhaul item during ROHs, averaging 24 man-days per equipment for repair.

Discussions with a San Diego depot inspector (communications) indicated that the AN/SRA-33 antenna couplers received by the depot for overhaul or repair usually did not require major repairs. Most of the time these antenna couplers required only a thorough cleaning and minor repairs.

Since the majority of the depot level AN/SRA-33 antenna coupler repairs have been minor and the AN/SRA-33 antenna couplers will be repaired during SRAs, class C repairs will be sufficient to support the antenna coupler for the first 20 months of the DDEOC intracycle. Therefore, it is recommended that the AN/SRA-33 antenna couplers receive class C repairs during BOH and subsequent ROHs.

The CG-16 and CG-26 Class DDEOC BOH requirements each specify a class B overhaul for the AN/SRA-33 antenna couplers. On the basis of this analysis it is recommended that this item be deleted from the CG-16 and CG-26 Class DDEOC BOH repair requirements.

3.6.8 Recommendations

The following recommendations for AN/SRA-33 antenna coupler maintenance are made for the CG-16 and CG-26 classes:

- A qualified CMP task should be included to accomplish class C repairs (at the depot level) of the AN/SRA-33 antenna coupler every 20 months, commencing at BOH.
- Depot personnel should train ship's force personnel to repair AN/SRA-33 antenna couplers during SRAs.

3.7 AN/URC-9 UHF TRANSCEIVER (SWAB 441-5) AND AN/WSC-3 UHF TRANSCEIVER (SWAB 441-7)

3.7.1 Background

The AN/URC-9 UHF transceivers on the CG-16 and CG-26 Class ships are scheduled for removal at BOH in accordance with shipalt CG-16-1291 and CG-26-471 for the CG-16 and CG-26 Classes, respectively. The AN/URC-9 UHF transceiver will be replaced by the AN/WSC-3 [line-of-sight (LOS) version] UHF transceiver.

The AN/WSC-3 is a UHF transceiver providing satellite and direct LOS communications in the 225 to 400 MHz range. In its total configuration, it provides both the satellite and LOS capabilities. The basic AN/WSC-3 UHF transceiver is a simple LOS AM transceiver without the more complex satellite modules. After BOH, a typical CG-16 or CG-26 Class ship will have three satellite systems and 16 LOS configurations.

3.7.2 Discussion

A review of the MIPs for the AN/WSC-3 transceiver did not reveal any requirements that would ordinarily require outside assistance. The PMS requirements for the AN/WSC-3 are considered adequate.

Since the AN/WSC-3 transceivers are new, solid-state equipment, they are not expected to present a significant maintenance burden during the EOC.

Review of the DDEOC repair requirements for BOH for the CG-16 and CG-26 Class ships indicated a requirement for a class B overhaul to the AN/URC-9 UHF transceiver. Since this equipment will be removed at BOH, it is recommended that the requirement for a class B overhaul be deleted from the DDEOC repair requirements for the CG-16 and CG-26 Class ships.

3.7.3 Recommendations

No recommendations were identified for the AN/WSC-3 transceivers.

Since the AN/URC-9 UHF transceiver is being removed at BOH, it is recommended that the requirement for a class B overhaul be deleted from the DDEOC repair requirements for the CG-16 and CG-26 Class ships.

3.8 AS-390A/SRC ANTENNA (SWAB 441-1)

3.8.1 Background

The AS-390A/SRC antenna (APL 59139000) is used on the CG-16 and CG-26 Class ships with the AN/URC-9 UHF transceivers. The AS-390A/SRC antenna was not on the *Selected Items for Analysis List* for the CG-16 Class because of its low maintenance burden. The AN/URC-9 UHF transceivers are being removed at BOH, but one antenna will remain on board for use with the AN/WSC-3 UHF transceivers.

3.8.2 Discussion

A review of the MDS data indicates that the CG-16 Class ships reported only 23 maintenance actions and the CG-26 Class reported 39 maintenance actions for the data period 1 January 1970 through 31 December 1977. Most of these maintenance actions were deferred for lack of facilities. Further investigation revealed that these deferrals were for antenna overhaul or relocation.

Review of MIPs for the AS-390A/SRC antenna revealed that the antenna is scheduled for removal and overhaul during shipyard availability (cyclical) in accordance with MIL C-405/3-14. Review of the SARPs indicated that one man-day was required per antenna. This task is a recommended engineered input to the CMP to be accomplished at ROH; it is also recommended for accomplishment at BOH.

The MDS parts usage data indicated that the AS-390A/SRC antenna was replaced seven times for the CG-16 Class and 22 times for the CG-26 Class. Only one CASREP was reported for the CG-26 Class, and none for the CG-16 Class. The relatively low maintenance burden (see table 3-1) for the CG-26 Class ships is only 59.7 man-hours per year of corrective maintenance for 31 antennas. With only nine antennas after BOH, the burden is expected to decrease for the EOC.

The AS-390A/SRC antenna is expected to perform satisfactorily during the EOC, provided the PMS requirements are performed as scheduled, the antenna is given a class B overhaul in accordance with MIP C-405/3-14 at BOH and subsequent ROH, and corrective maintenance is performed as necessary.

3.8.3 Recommendations

The following recommendations apply to the AS-390A/SRC antenna on the CG-16 and CG-26 Class ships:

- Accomplish class B overhaul at the depot level in accordance with MIP C-405/3-14 at BOH.
- Include an engineered task in the CMP to accomplish class B overhaul at the depot level in accordance with MIP C-405/3-14 at ROH.

3.9 AN/VRC-46 VHF TRANSCEIVER (SWAB 441-5) (APL 58841200)

3.9.1 Background

The AN/VRC-46 VHF transceiver has an output power of 35 watts and operates within a frequency range of 30 to 75.95 MHz. The AN/VRC-46 was not selected for analysis on the CG-26 Class because of its low maintenance burden. Six of the CG-16 Class ships and five of the CG-26 Class ships have one AN/VRC-46 transceiver installed.

3.9.2 Maintenance Summary

Review of the CG-16 Class MDS data revealed that only 42 maintenance actions were reported against the AN/VRC-46 APL during the data period. These actions consisted primarily of miscellaneous nonrepetitive repairs, including installation and relocation of equipment, antenna repairs, and minor parts replacements. Analysis of parts usage data did not indicate excessive use of any AN/VRC-46 parts, and only two CASREPs were submitted on the transceiver, neither of which indicated a major repair problem or significant downtime awaiting parts. From the maintenance burden data reported, it was concluded that ship's force can adequately maintain the AN/VRC-46 during an extended operating cycle with only a minimum of outside assistance. It was also determined that no periodic scheduled maintenance is necessary for the AN/VRC-46 beyond those requirements currently contained in the PMS and that a run-to-failure (with routine PMS accomplishment) maintenance strategy is adequate to ensure satisfactory operation throughout an extended operating cycle; therefore, no maintenance strategy changes are recommended.

Three of six SARPs reviewed indicated class C repairs to the AN/VRC-46 transceiver to be accomplished by ship's force. Therefore, it is recommended that class C repairs, as required by POT&I and CSMP, be accomplished at BOH. It is also recommended that a qualified task be included in the CMP to accomplish class C repairs as required by POT&I and CSMP.

3.9.3 Recommendations

The following recommendations are applicable to the AN/VRC-46 transceiver on the CG-16 and CG-26 Class ships:

- Accomplish class C repairs as required by POT&I and CSMP at BOH.
- Include a qualified task in the CMP for the ship's force to accomplish class C repairs as required by POT&I and CSMP at ROH.

3.10 AN/URC-80(V)5 VHF TRANSCEIVER (SWAB 441-5)

3.10.1 Background

The AN/URC-80(V)5 transceiver provides VHF FM bridge-to-bridge communications capability. One AN/URC-80(V)5 transceiver is installed on each ship in the CG-16 and CG-26 Classes.

3.10.2 Maintenance Burden

For the AN/URC-80(V)5 transceiver, only two maintenance actions were reported by the CG-16 Class ships and six maintenance actions were reported by the CG-26 Class ships.

Review of the MDS narratives indicated that the maintenance actions performed by ship's force and IMA were miscellaneous nonrepetitive repairs that did not require any significant parts usage. No CASREPs were reported by the CG-16 Class or CG-26 Class ships. Review of the MDS parts data did not reveal any significant parts usage for the AN/URC-80(V)5 transceiver. Therefore, it is concluded that ship's force personnel, with minimal outside assistance, can perform most major maintenance actions on the AN/URC-80(V)5 transceiver.

3.10.3 Maintenance Strategy

A review of the MIPs for the AN/URC-80(V)5 transceiver did not reveal any maintenance requirements that would ordinarily require outside assistance. The PMS requirements for the AN/URC-80(V)5 transceiver are considered adequate.

There is no evidence to indicate that the AN/URC-80(V)5 transceiver requires major restorative maintenance before or during an extended operating cycle. Therefore, it is concluded that the AN/URC-80(V)5 transceiver can be kept operational if a run-to-failure maintenance strategy is adopted and the present PMS requirements are accomplished during an extended operating cycle.

Two of six SARPs indicated a requirement for class C repairs to be accomplished by ship's force. Therefore, it is recommended that class C repairs, as required by POT&I and CSMP, be accomplished at BOH. It is

also recommended that a qualified task be included in the CMP for class C repairs to be accomplished at ROH as required by the POT&I and CSMP.

3.10.4 Recommendations

The following recommendations are applicable to the AN/URC-80(V)5 transceivers on the CG-16 and CG-26 Class ships:

- Accomplish class C repairs as required by POT&I and CSMP at BOH.
- Include a qualified task in the CMP for the ship's force to accomplish class C repairs as required by POT&I and CSMP at ROH.

3.11 AN/WRR-3 (SERIES) RECEIVERS (SWAB 441-4)

3.11.1 Background

The AN/WRR-3 (series) low-frequency receivers are used on the CG-16 and CG-26 Class ships. The configuration for the CG-16 and CG-26 Class ships varies, with some ships having only one AN/WRR-3 (series) receiver and others having as many as four. The AN/WRR-3 (series) receivers consist of two basic types as shown in table 3-25.

Table 3-25. AN/WRR-3( ) RECEIVERS FOR THE CG-16 AND CG-26 CLASS SHIPS

Nomenclature	APL	Quantity, CG-16 Class	Quantity, CG-26 Class
AN/WRR-3	59005300	0	21
AN/WRR-3B	59005302	22	0

These two transmitters are similar and differ only in manufacturer. The AN/WRR-3 receiver is on board the CG-26 Class ships, and the AN/WRR-3B is on board the CG-16 Class ships. Therefore, the AN/WRR-3 and the AN/WRR-3B will be discussed together as an AN/WRR-3 (series) receiver throughout this report.

3.11.2 Maintenance Burden Summary

Comparison of the maintenance actions between the CG-16 and CG-26 Class ships showed both classes displaying the same type maintenance pattern; therefore, for ease of presentation and discussion, the data were combined.

The following summary identifies the maintenance experience, as shown in tables 3-26 through 3-28, for the AN/WRR-3 (series) receiver:

- Maintenance actions usually required less than 10 ship's force man-hours (83 percent of the JCNs with reported man-hours).
- Normal wear and tear was the major cause for maintenance actions (69 percent of total JCNs with reported man-hours).
- A majority of the maintenance actions required parts replacement (68 percent of the JCNs with reported man-hours).
- Few IMA maintenance actions were required for ship's force support (8 percent of the deferral JCNs).
- Maintenance action deferrals were usually due to lack of material (parts) (37 percent of the deferral JCNs or 14 percent of the total JCNs).
- Ship's force completed a majority of the deferrals (71 percent of the deferral JCNs).

Therefore, it is concluded that ship's force personnel, with minimal outside assistance, can perform most major maintenance actions on the AN/WRR-3 (series) receiver.

Although the percentage of deferrals due to lack of material appears to be high (37 percent of deferral JCNs), it represents only 24 transactions for 43 receivers during an eight-year data period. Analysis of MDS parts data also revealed no significant parts usage.

Analysis of CASREP data for the CG-16 and CG-26 Class ships indicated that no CASREPs were submitted for the AN/WRR-3 (series) receivers for the CG-16 Class and that only five were reported by the CG-26 Class. The few CASREPs reported nonrepetitive repairs and did not indicate any major problems with the AN/WRR-3 (series) receivers.

A review of the MIPs for the AN/WRR-3 (series) receiver did not reveal any maintenance requirements that would require outside assistance.

Three of six SARPs reviewed indicated that the AN/WRR-3 (series) receivers would require a depot-level class B overhaul during shipyard availability. The available MDS data, parts usage, and CASREPs do not support the requirement for a class B overhaul. Therefore, class C repairs as required by POT&I and CSMP are recommended for BOH and follow-on ROH.

On the basis of this analysis, it was concluded that the ship's force personnel of both classes can adequately maintain the AN/WRR-3 (series) receivers through an extended operating cycle with a minimum of outside assistance, provided the equipment receives class C repairs at BOH, PMS requirements are performed as scheduled, and corrective maintenance is performed as necessary. Therefore, it is recommended that the AN/WRR-3 (series) receivers be given class C repairs at the depot level as required by POT&I and CSMP at BOH and follow-on ROH.

Table 3-26. MAN-HOUR SUMMARY FOR CG-16 AND CG-26 CLASS AN/WRR-3( ) RECEIVERS

JCN Type	Man-Hour Distribution		Number of Transactions
	Range of Man-Hours	Percentage of Total JCNs with Man-Hours	
Ship's	0 - 10	83	103
Force	11 - 30	15	18
JCNs	31 or more	2	3
IMA	0 - 10	2	3
JCNs	11 or more	6	7

Total JCNs = 170.
Parts-only transactions = 46 (27%) of total JCNs.
Transactions with reported man-hours = 124 (73%) of total JCNs.
Both ship's force and IMA man-hours may be reported on a particular JCN.

Table 3-27. MDS SUMMARY OF JCN CAUSE AND ACTION TAKEN CODES FOR CG-16 AND CG-26 CLASS AN/WRR-3( ) RECEIVERS

Data Item	Percentage of Total JCNs with Reported Man-Hours	Number of Transactions
Reported Cause		
Normal Wear and Tear	69	86
Manufacturer Defects	0	0
Lack of Training	0	0
Abnormal Environment	2	2
Other and Unknown	29	36
Action Taken		
Completed with Parts	68	85
Completed (No Parts)	10	12
Cancelled	-	-
Other and Unknown	22	27

Table 3-28. MDS SUMMARY OF DEFERRED JCNs FOR CG-16 AND CG-26 CLASS AN/WRR-3( ) RECEIVERS

Data Item	Percentage of Total JCNs with Man-Hours	Number of Transactions
Deferral Reason		
Lack of Materials	37	24
Lack of Facilities	18	12
Work Backlog/Priority	26	17
Inadequate Training	-	-
Other and Unknown	19	12
Type Availability		
Depot	12	8
IMA	8	5
Ship's Force	71	46
Unknown	9	6

Deferred JCNs = 65 (38%) of total JCNs).

3.11.3 Recommendations

The following recommendations are applicable for the AN/WRR-3 (series) receivers on the CG-16 and CG-26 Class ships:

- Accomplish class C repairs at the depot level at BOH as required by POT&I and CSMP.
- Include a qualified task in the CMP for class C repairs at the depot level as required by POT&I and CSMP.

3.12 AN/SRA-17 ANTENNA COUPLER (SWAB 441-2)

The AN/SRA-17 low-frequency antenna couplers on the CG-16 and CG-26 Class ships have been removed. Therefore, a maintenance analysis was not accomplished for the AN/SRA-17 antenna couplers.

3.13 TELETYPE AND FACSIMILE GROUP (SWAB 445-1)

The CG-16 and CG-26 Class teletype equipment selected for analysis included the following model 28 teletypewriter sets:

Category	Nomenclature
Automatic Send and Receive (ASR)	AN/UGC-6F AN/UGC-6K AN/UGC-6L AN/UGC-13 AN/UGC-13(mod) AN/UGC-16
Keyboard Send and Receive (KSR)	AN/UGC-20 AN/UGC-20A AN/UGC-20B
Receive Only (RO)	AN/UGC-25 AN/UGC-25A
Auxiliary Equipment (AUX)	TT-192 TT-192A TT-192B

The model 28 teletypewriter sets are grouped into four categories: automatic send and receive (ASR), keyboard send and receive (KSR), receive only (RO), and auxiliary (AUX). The ASR teletypewriter sets are capable of generating and receiving teletype messages. Each ASR set contains two receiving devices: a page printer and a reperforator (REPERF); and two generating devices: a keyboard and a transmitting distributor (TD). The page printer provides a printed copy of the teletype message. The REPERF provides a punched paper tape of the teletype code for the message, with the message printed along the edge of the tape. The keyboard is an electromechanical device that generates the appropriate teletype electrical

code for each letter, figure, or control function as the respective keys are depressed. The TD is an electromechanical device that reads the paper tape produced by the REPERF and converts the punched codes into the appropriate electrical code of the teletype message.

The KSR, RO, and AUX teletypewriter sets are similar in function and operation to the individual teletype components that make up the ASR teletypewriter set. They are, in fact, the same teletype components housed in smaller cases; therefore, the discussion presented in the following paragraphs will address the model 28 teletypewriter sets as a family.

In addition to the teletypewriter sets in SWAB 445-1, this section will also discuss the teletype components of the Mk 77 I/O console associated with the Terrier missile system computer under SWAB 482. The Mk 77 I/O console teletype equipment is used to communicate with the Terrier missile system computers. Three pieces of teletypewriter equipment and the electronic circuitry required to convert the teletype codes into those usable by the computer, and vice versa, constitute the Mk 77 I/O console. The teletype equipment includes a model 35 KSR teletypewriter set, a high-speed reperforator (HS-REPERF), and a high-speed tape reader (HS-TR). The model 35 KSR teletypewriter set is similar in function and operation to the model 28 KSR teletypewriter set. The HS-REPERF produces a punched tape of the computer output data similar to the model 28 REPERF, the differences being that there is no printing on the tape and the HS-REPERF operates at about 10 times the speed of the model 28 REPERF. The HS-TR reads the punched tapes produced by the HS-REPERF, using an electro-optical principle, for programming or entering data into the computer.

No facsimile equipment was selected for analysis.

3.13.1 Model 28 Teletypewriter Sets

Background

As noted in table 3-29, the individual model 28 teletypewriter sets are installed in both the CG-16 and CG-26 Class ships in various quantities and combinations, with no two ships in either the CG-16 or CG-26 Class having the same combination. A summary of the MDS data for the individual model 28 teletypewriter sets is presented in table 3-30.

Detailed analysis of the MDS data and the associated narratives for each of the model 28 teletypewriter sets indicated that the same maintenance pattern was present on both CG-16 and CG-26 Class ships. The analysis indicated that approximately 44 percent of the total documented maintenance man-hours were directly associated with the equipment's PMS requirements (MIPs C-58/1-66, C-89/1-66, C-368/1-66, and TD-46/1-A7), and approximately the same percentage (44 percent) were associated with class B overhauls. Approximately nine percent of the maintenance man-hours were expended on corrective maintenance; the remaining three percent were expended on other miscellaneous actions.

Table 3-29. CG-16 AND CG-26 CLASS TELETYPE SYSTEM CONFIGURATION DATA

Nomenclature	AEL	CG-16 Class Ships									CG-26 Class Ships								
		16	17	18	19	20	21	22	23	24	26	27	28	29	30	31	32	33	34
Automatic Send and Receive Equipment																			
AN/UGC-6	58138200	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AN/UGC-6B	58138211	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
AN/UGC-6F	58138230	-	-	-	-	-	-	-	-	-	-	-	-	3	3	3	3	3	3
AN/UGC-6K	58138242	3	2	2	3	3	2	2	2	2	-	-	5	-	1	1	-	-	-
AN/UGC-6L	58138243	-	-	-	-	-	1	-	-	1	2	-	-	-	-	2	-	-	-
AN/UGC-13	58138900	-	-	-	2	2	2	-	-	-	-	-	2	-	-	-	2	-	-
AN/UGC-13(mod)	58138925	-	-	2	1	1	2	-	-	2	-	-	-	-	-	-	-	-	-
AN/UGC-13A(mod)	58138950	2	2	-	1	1	-	2	-	2	2	2	2	2	2	2	2	1	3
AN/UGC-16	58139050	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-
Keyboard Send and Receive Equipment																			
AN/UGC-20	58139031	-	1	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-
AN/UGC-20A	58139029	1	3	-	3	1	6	1	4	-	3	7	2	1	5	1	1	-	2
AN/UGC-20B	58139038	2	-	1	-	3	1	-	-	4	-	-	2	-	2	-	-	-	-
Receive Only Equipment																			
AN/UGC-25	58139036	-	-	-	-	1	-	-	-		2	2	1	-	1	-	1	-	1
AN/UGC-25A	58139025	6	11	6	7	6	9	8	6	10	12	11	8	9	14	13	8	7	9
Auxiliary Equipment																			
TT-192/UG	92834300	1	1	-	1	-	-	-	-	-	1	1	-	-	-	-	-	-	-
TT-192A/UG	92834305	-	5	2	3	-	-	-	2	-	8	5	2	7	6	3	6	5	3
TT-192B/UG	92834307	3	5	2	4	3	9	3	2	8	-	3	1	2	9	2	4	1	1

Table 3-30. MDS DATA SUMMARY OF SELECTED MODEL 28 TELETYPE SYSTEM EQUIPMENTS FOR THE CG-16 AND CG-26 CLASSES

Equipment Category*	APL	Nomenclature	Applicable Ships	Components per Ship	Total Component Population	Total Ship Operating Time (Ship-Years)	Ships Reported	JCNs	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Average Man-Hours per Component per Operating Year
CG-16 Class												
ASR	58138242	AN/UGC-6K	9	2-3	21	52.2	9	420	1,010	885	1,895	15.7
	58138243	AN/UGC-6L	2	1	2	13.0	2	3	11	176	187	16.4
	58138900 58138925 58138950	AN/UGC-13( )	9	2	24	52.2	9	54	227	41	268	2.9
KSR	58139029	AN/UGC-20A	7	1-6	22	40.1	8	90	184	272	456	3.6
	58139031	AN/UGC-20	2	1	2	11.7	3	9	1	0	1	0.1
	58139038	AN/UGC-20B	5	1-4	11	30.5	3	12	191	1	192	2.9
RO	58139025 58139036	AN/UGC-25( )	9	6-11	71	52.2	9	592	1,497	1,105	2,602	6.2
AUX	92834300 92834305 92834307	TT-192( )/UG	9	3-11	54	52.2	9	49	389	107	491	1.5
CG-26 Class												
ASR	58138230	AN/UGC-6F	6	1	18	40.7	6	387	2,900	1,604	4,504	36.9
	58138242	AN/UGC-6K	3	1-5	7	20.6	5	22	71	0	71	1.4
	58138243	AN/UGC-6L	2	2	4	12.0	1	2	2	27	29	1.2
	58138900 58138950	AN/UGC-13( )	9	1-3	22	60.4	9	52	274	35	309	2.1
	58139050	AN/UGC-16	2	3	6	12.5	5	125	339	423	762	20.3
KSR	58139029	AN/UGC-20A	8	1-7	22	53.3	7	175	388	718	1,106	7.5
RO	58139025 58139036	AN/UGC-25( )	9	7-15	99	60.4	9	991	2,231	2,219	4,450	6.8
AUX	92834300 92834305 92834307	TT-192( )/UG	9	3-15	70	60.4	9	193	568	774	1,342	3.1
DDG-37 Class												
ASR	58138242	AN/UGC-6K	10	2	20	54.0	9	136	400	204	604	2.6
	58138900	AN/UGC-13	10	2	20	54.0	10	129	869	52	921	8.5
	58139050	AN/UGC-16	1	1	1	5.4	1	9	121	54	175	32.4
KSR	58139029	AN/UGC-20A	3	3	9	16.2	2	23	113	137	250	5.1
	58139031	AN/UGC-20	7	2	14	34.8	7	53	285	133	418	5.5
RO	58139025	AN/UGC-25A	10	4	40	54.0	8	181	464	205	669	3.1
	58139036	AN/UGC-25	10	5	50	54.0	10	385	1,253	748	2,001	7.4

*ASR = Automatic Send and Receive.
KSR = Keyboard Send and Receive.
RO = Receiver Only.
AUX = Auxiliary.

Planned Maintenance

As previously indicated, a majority of the maintenance burden for the model 28 teletypewriter sets was a result of the PMS and class B overhaul requirements. The ship's force teletype repairmen, radiomen with the Navy enlisted classification code of 2342 (RM-2342), performed the Q-1R and Q-2R PMS requirements; however, in a majority of cases, the R-1 requirement was performed by an IMA. Although the shipboard teletype repairmen are fully capable of performing all PMS requirements, the ships of both CG-16 and CG-26 Classes lack the facilities, such as a gunk tank or sonic cleaner and adequate bench space, to support their efforts, and IMA assistance is requested in accordance with the directions given in the MIPs. The MIPs state "MRC R-1 (S-1R on TD-46/1-A7) should be scheduled for accomplishment by a teletype repair activity if proper teletype repair facilities to disassemble, clean, and reassemble teletype equipment are not on board". Review of the MDS data indicates that the R-1 PMS requirement was accomplished by an IMA on the model 28 teletypewriter sets at least annually, and semiannually on the AN/UGC-13(mod) in accordance with the S-1R requirement on MIP TD-46/1-A7. The periodicity and the strategy of having the IMA perform these major PMS requirements appear adequate to support the equipment during the extended operating cycle. Therefore, it is recommended that the CMP include a qualified task for annual class C repairs in support of the R-1 PMS requirements on all model 28 [less the AN/UGC-13(mod)] teletypewriter sets (MIPs C-58/1-66, C-89/1-66, and C-368/1-66). In addition, it is recommended that the CMP include a semiannual qualified task for class C repairs in support of the S-1R PMS requirement on the AN/UGC-13 (mod) teletypewriter set (MIP TD-46/1-A7).

Equipment Overhauls

Class B overhauls were accomplished on the model 28 teletypewriter sets periodically through the data period. As previously indicated, approximately 44 percent of the documented man-hours were for class B overhauls. The majority of the class B overhauls were accomplished by an IMA, with an occasional (less than 10 percent) overhaul being accomplished by the ship's force teletype repairmen, using outside facilities such as those available at some mobile training unit (MOTU) locations. Review of the SARPs indicates that class B overhauls appeared on 6 of 11 SARPs for the CG-16 Class and 10 of 11 SARPs for the CG-26 Class. This requirement for class B overhauls on all teletypewriter sets will continue throughout the extended operating cycle. Therefore, it is recommended that the CMP include an engineered task for class B overhauls on all teletypewriter sets at the IMA level, to be accomplished at ROH, to reduce the incidence of class B overhauls during the intracycle.

The DDEOC repair requirements for BOH for the CG-16 Class lists class B overhauls for only the AN/UGC-6( ) and AN/UGC-25( ) teletypewriter sets; for the CG-26 Class it lists class B overhauls for all model 28 teletypewriter sets, except the AN/UGC-16. As indicated in the previous discussion, class B overhauls are required on all model 28 teletypewriter sets. Therefore, it is recommended that the DDEOC repair requirements for both CG-16 and CG-26 Classes be changed to include class B overhauls on all model 28 teletypewriter sets.

Casualty Reports

Review of the CASREP data indicates that a total of seven CASREPs were submitted on model 28 teletypewriter sets. Three CASREPs were submitted by two CG-16 Class ships, for a total downtime of 1,967 hours. Eighteen percent (356 hours) was spent awaiting parts, and 82 percent (1,611 hours) was spent for maintenance. Four CASREPs were submitted by two CG-26 Class ships, for a total downtime of 1,127 hours. Thirty-four percent (379 hours) was spent awaiting parts, and 66 percent (748 hours) was spent for maintenance.

The CASREPs submitted by the CG-16 Class ships included the overhaul of the entire teletype suite as the result of disapproved or rejected work requests, repair of an AN/UGC-20A teletypewriter set involved in a class C fire, and the repair of four inoperative AN/UGC-25A teletypewriter sets for which parts were not on board. The CASREPs submitted by the CG-26 Class ships included repair of an AN/UGC-6 teletypewriter set requiring outside assistance, tender overhaul of an unidentified quantity of teletypewriter sets as a result of disapproved or rejected work requests, repair of one AN/UGC-25 that required parts not on board, and a radio frequency filter for an AN/UGC-13. The number of CASREPs was considered too small to establish any trend or pattern; however, it was noted that four of the seven CASREPs required outside assistance, two of which involved the prior disapproval or rejection of outside assistance work requests, indicating the CG-16 and CG-26 Class ships' dependence on the IMA for maintenance of teletype equipment and the need for continued class C repairs support by the IMA.

High-Maintenance-Burden Equipment

The AN/UGC-6F and AN/UGC-16 teletypewriter sets, installed in the CG-26 Class only, exhibited the highest maintenance burdens, 36.9 and 20.3 man-hours per equipment per operating year, respectively, of the model 28 teletypewriter sets on both CG-16 and CG-26 Classes. Although there were no CASREPs or parts problems on these two sets, their high maintenance burdens, some 10 to 17 times higher than the other model 28 ASR teletypewriter sets installed in the CG-26 Class, caused them to warrant special consideration. It appears that the frequency of maintenance rather than the type of maintenance was the cause of the high maintenance burden on both the AN/UGC-6F and AN/UGC-16 teletypewriter sets. The types of maintenance actions performed on these two sets were similar to those performed on the other model 28 teletypewriter sets but were more frequent. As an example, the R-1 PMS requirement was performed approximately every six months, as opposed to the 8 to 12 months for the other model 28 teletypewriter sets. In addition, approximately 34 percent of the documented man-hours on the AN/UGC-6F and 48 percent of the documented man-hours on the AN/UGC-16 were for corrective maintenance, as opposed to the average of 9 percent corrective maintenance for the model 28 teletypewriter sets as a whole. It appears that the increased corrective maintenance and more frequent preventive maintenance is a result of the age and lack of the latest equipment modifications on the AN/UGC-6F and AN/UGC-16 teletypewriter sets. The Naval Ship Engineering Center Ship Type Electronics Plan (NAVSHIPS 0900-001-2000) categorizes electronic equipment, including

teletypewriter sets, into subcategories (SCATs) and classifies the individual equipments within each SCAT as "standard", "limited standard", "obsolescent", or "obsolete". All model 28 ASR teletypewriter sets are in the same SCAT, with the AN/UGC-6F classified as "limited standard" and the AN/UGC-16 classified as "obsolete". Discussion with the technical personnel at Naval Electronics Systems Command (NAVELEX) and ships parts control center (SPCC), Mechanicsburg, Pennsylvania, revealed that there is a "modification program" that updates all AN/UGC-6( ) teletypewriter sets (models AN/UGC-6 through AN/UGC-6J) to the AN/UGC-6K, although no ship-by-ship schedule has been established for the completion of the program. The discussion also revealed that, although the AN/UGC-16 is classified as "obsolete", there is no update program for or plans to replace the AN/UGC-16 teletypewriter sets. It is recommended that the AN/UGC-6F teletypewriter sets, installed in the CG-26 Class ships, be scheduled for modification or updating to the AN/UGC-6K at BOH. In addition, as a result of the high maintenance burden, age, and "obsolete" classification of the AN/UGC-16, it is recommended that the AN/UGC-16 teletypewriter sets, installed in the CG-26 Class ships, be replaced with the AN/UGC-6K teletypewriter sets or equivalent at BOH.

Parts Usage

Review of the parts-usage data on both CG-16 and CG-26 Class ships revealed no significant parts usage with regard to quantity used or cost of individual parts. The majority of the parts used were those associated with the equipment PMS requirements, such as felt pads and washers, springs, screws, panels, and levers; parts support for the model 28 teletypewriter sets appears to be adequate to support the extended operating cycle.

Maintenance Strategy

The existing maintenance strategy for the model 28 teletypewriter sets consists of periodic class B overhauls and performance monitoring of the teletypewriter sets as part of the PMS program. On the basis of this analysis, the model 28 teletypewriter sets in both the CG-16 and CG-26 Class ships are expected to perform satisfactorily during the extended operating cycle provided the AN/UGC-6Fs are updated to and the AN/UGC-16s are replaced by the AN/UGC-6K teletypewriter set, PMS requirements are performed as scheduled, and corrective maintenance and overhauls are performed as necessary.

Recommendations

The following recommendations apply to the model 28 teletypewriter sets on the CG-16 and CG-26 Class ships and are recommended for accomplishment at BOH:

- Change the DDEOC repair requirements for BOH to include class B overhauls on all model 28 teletypewriter sets.
- Complete the "modification program" on all AN/UGC-6F teletypewriter sets to update them to the AN/UGC-6K model (CG-26 Class only).

- Replace the AN/UGC-16 teletypewriter sets with the AN/UGC-6K model or equivalent (CG-26 Class only).

The following recommendation applies to the model 28 teletypewriter sets on the CG-16 and CG-26 Class ships and is a recommended input for the CMP to be accomplished at ROH: include an engineered task to provide a class B overhaul at the IMA level on all model 28 teletypewriter sets.

The following recommendations apply to the model 28 teletypewriter sets on the CG-16 and CG-26 Class ships and are recommended inputs for the CMP intracycle maintenance requirements.

- Include a qualified task to provide annual class C repairs at the IMA level on all model 28 teletypewriter sets, less the AN/UGC-13 (mod), in support of PMS requirements. (The R-1 requirement on MIPs C-58/1-66, C-89/1-66, and C-368/1-66 applies.)
- Include a qualified task to provide semiannual class C repairs at the IMA level on the AN/UGC-13(mod) in support of PMS requirements (MIP TD-46/1-A7 S-1R applies).

3.13.2 Mk 77 Input/Output (I/O) Console Teletype Equipment

Background

Four Mk 77 I/O consoles are currently installed on five of the CG-16 Class ships, CG-16, -17, -19, -21, and -24; and two Mk 77 I/O consoles are installed on each of the CG-26 Class ships.

The APL (49402774) for the Mk 77 I/O console includes the console's electronics as well as teletype equipment; therefore, the MDS data presented in table 3-31 are for the Mk 77 I/O console as a whole and not just the teletype equipment. The maintenance burdens for the Mk 77 I/O console on the CG-16 and CG-26 Classes were four and eight man-hours per equipment per operating year, respectively. There were no CASREPs on the Mk 77 I/O console.

Corrective Maintenance

A review of the MDS data and the associated narratives was conducted for both CG-16 and CG-26 Classes to determine the amount of maintenance that was accomplished on the teletype equipment as opposed to the console's electronics. The results of the review indicated that the CG-16 Class ships documented 7 out of 58 maintenance actions on the teletype equipment, accounting for 21 percent of the man-hours. The CG-26 Class ships documented 210 out of 386 maintenance actions on the teletype equipment, accounting for 65 percent of the man-hours. The seven maintenance actions on the CG-16 Class ships were not considered to be a sufficient number to establish any patterns; however, analysis of the CG-26 Class data indicated that the man-hours expended on the maintenance of the teletype equipment were approximately 13 percent on PMS, 35 percent on overhauls, and 52 percent on corrective maintenance. The maintenance actions performed were similar to those found in the analysis of the model 28 teletypewriter sets. The higher percentage of corrective maintenance appears to be a result of

Table 3-31. MDS DATA SUMMARY OF MK 77 INPUT/OUTPUT CONSOLE (APL 49402774)

Ship Class	Applicable Ships	Components per Ship	Total Component Population	Total Ship Operating Time (Ship-Years)	Ships Reported	JCNs	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Average Man-Hours per Component per Operating Year
CG-16	5	4	20	10.4	5	58	146	2	148	4
CG-26	9	2	18	25.0	8	107	338	48	386	8

the lack of training in the maintenance and repair of teletype equipments on behalf of the fire control technicians (FTs). The MDS narratives, from both CG-16 and CG-26 Class ships, also indicated problems in the PMS on the teletype equipment when accomplished by the FTs, as they "have no training in the maintenance and repair of teletype equipment".

Planned Maintenance

The PMS documentation, MIPs 5ORD005/2-92 and 5ORD005/41-46, indicates that the FTs are to perform all maintenance on the Mk 77 I/O console. Review of the PMS documentation for other computer system I/O devices shows that the maintenance responsibility for the teletype equipment is usually assigned to the ships' teletype repairmen. However, the FTs are responsible for the Mk 77 I/O console. The teletype repairmen are tasked with the accomplishment of the corrective and PMS requirements that require their special training, and those PMS requirements on the teletype equipment classified as "operator maintenance" remained the responsibility of the systems technicians. It is recommended that the maintenance responsibility for the Mk 77 I/O console be split between the FTs and teletype repairmen in much the same way as for other computer system I/O consoles, thus taking advantage of the training and experience of the teletype repairmen. It is recommended that the following maintenance requirements be assigned to the teletype repairmen (RM-2342):

MIP	Maintenance Requirements
5ORD005/2-97	M-3/Q-5, M-6, Q-1, Q-2, S-2, A-1, and A-2
5ORD005/U1-46	R-2 through R-46

It is noted that the A-1 requirement is similar to the model 28 teletypewriter set R-1 requirements previously recommended for completion by the IMA; therefore, it is recommended that a qualified task be included in the CMP for class C repairs on the Mk 77 I/O console's teletype equipment in support of the A-1 PMS requirement (MIP 5ORD005/2-97).

Parts Usage

Review of the parts usage data for the Mk 77 I/O console indicated that parts usage was predominantly for the electronics of the console, i.e., printed circuit cards. Parts used on the teletype equipment were similar to those found in the analysis on the model 28 teletype equipment: felt pads, washers, springs, and levers. Parts support appears adequate to support the equipment during the extended operating cycle.

Equipment Overhauls

Review of the SARPs for both CG-16 and CG-26 Classes revealed no class B overhaul requirements on the Mk 77 I/O console teletype equipment. However, as mentioned in the previous paragraph, approximately 35 percent of the documented man-hours on the CG-26 Class Mk 77 I/O console teletype

were for overhauls, and this teletype's similarities to the model 28 teletypewriter set's maintenance suggests that class B overhauls will be required at BOH and subsequent ROHs. The current DDEOC repair requirements for the CG-16 and CG-26 Classes do not include a class B overhaul for the Mk 77 I/O console, and it is recommended that it be changed to include a class B overhaul on the Mk 77 I/O console. In addition, it is recommended that an engineered task be included in the CMP for class B overhaul on the Mk 77 I/O console's teletype equipment at ROH.

Recommendations

It is recommended that the DDEOC repair requirements list for accomplishment at BOH be changed to add a class B overhaul of the Mk 77 I/O console's teletype equipment.

For the Mk 77 I/O console's teletype equipment on the CG-16 and CG-26 Class ships it is recommended that an engineered task be included to provide a class B overhaul at the IMA level on the Mk 77 I/O console's teletype equipment at ROH (54-month periodicity).

For the Mk 77 I/O console's teletype equipment on the CG-16 and CG-26 Class ships, a qualified task should be included to provide class C repairs on an annual basis on the Mk 77 I/O console's teletype equipment in support of PMS requirements (MIP 5ORD005/2-97, A-1). (This is also a recommended input for the CMP intracycle maintenance requirements.)

For the Mk 77 I/O console's teletype equipment on the CG-16 and CG-26 Class ships, the maintenance responsibility should be split between the system's prime technicians, FTs, and teletype repairmen, RM-2342, to take advantage of the experience and training of the teletype repairmen. The recommended distribution of the PMS requirement is as follows:

Rate	MIP	MRC
FT	5ORD005/2-97	W-3, M-5/Q-7, Q-3, Q-4, Q-8, S-1, S-3, LU-1, and SU-1
	5ORD005/U1-46	R-1
RM	5ORD005/2-97	M-3/Q-5, M-6, Q-1, Q-2, S-2, A-1, and A-2
	5ORD005/U1-46	R-2 through R-46

CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

The following significant conclusions resulted from this review of experience:

- Ship's force personnel have the capability to perform most major maintenance actions for the radio systems.
- The teletype systems usually require IMA assistance to accomplish major repairs because of the lack of shipboard facilities.
- The majority of the radio equipment will not need major overhaul at BOH and ROH; class C repairs should be sufficient.
- The antennas will require class B overhaul at BOH and ROH.
- Ship's force personnel are not adequately trained to maintain the AN/SRA-33 antenna coupler.
- The teletype systems will require class B overhaul at BOH and ROH in addition to intracycle requirements for class C repairs.
- Standardization of the model 28 teletype suites should improve reliability and maintainability of the teletype equipment.
- Replacement of the AN/UGC-16 teletype with the AN/UGC-6K should improve reliability and maintainability of the teletype equipment.
- Labeling of the different R-1051( )/URR receivers and the respective modules with warning labels that show model type and module substitution applicability should decrease the parts usage and improve the reliability of the R-1051( )/URR receivers.

4.2 RECOMMENDATIONS

Recommendations for corrective action and improvement for exterior communications systems' equipment maintenance are categorized as follows:

- BOH requirements
- Intracycle maintenance requirements

- Follow-on ROH requirements
- Reliability and maintainability improvements
- IMA improvements
- Integrated logistics support (ILS) improvements
- Industrial facility improvements

Table 4-1 summarizes the specific recommendations resulting from the analysis of the exterior communications systems.

Table 4-1. SUMMARY OF ROE RECOMMENDATIONS FOR CG-16 AND CG-26 CLASS EXTERIOR COMMUNICATIONS SYSTEMS

Recommendation Number	Component	Recommendation	Reference Paragraph
		Baseline Overhaul Requirements	
1	AN/URT-23( ) transmitter	Accomplish class C repairs as required by POT&I and CSMP.	3.2.5
2	R-1051( )/URR/HF transmitter	Accomplish class C repairs as required by POT&I and CSMP.	3.2.7
3	R-390A/URR HF receiver	Accomplish class C repairs as required by POT&I and CSMP.	3.4.4
4	AN/URA-38 antenna coupler	Accomplish class B overhaul in accordance with MIP C-389/1-66.	3.5.2
5	AN/SRA-22 antenna coupler	Delete the requirement for a class B overhaul from the DDEOC repair requirements.	3.5.2
6	AN/SRA-33 antenna coupler	Accomplish class C repairs as required by POT&I and CSMP	3.6.7
7	AN/URC-9 transceiver	Delete the requirement for a class B overhaul from the DDEOC repair requirements.	3.7.2
8	AS-390A/SRC antenna	Accomplish class B overhaul in accordance with MIP C-405/3-14.	3.8.2
9	AN/VRC-46 transceiver	Accomplish class C repairs as required by POT&I and CSMP.	3.9.2
10	AN/URC-80 transceiver	Accomplish class C repairs as required by POT&I and CSMP.	3.10.3
11	AN/WRR-3( ) receiver	Accomplish class C repairs as required by POT&I and CSMP.	3.11.2
12	Model 28 teletypewriter sets and the Mk 77 input/output console teletype equipment	Accomplish class B overhaul on all model 28 teletypewriter sets and the Mk 77 input/output console teletype equipment	3.13.1.2 3.13.2.2
		Intracycle Requirements	
13	Model 28 teletypewriter sets	Accomplish class C repairs on all model 28 teletypewriter sets, less the AN/UGC-13 (mod) on an annual basis in support of the following PMS requirements: MIP C-58/1-66 R-1 MIP C-89/1-66 R-1 MIP C-368/1-66 R-1	3.13.1.2
14	AN/UGC-13 (mod) teletypewriter sets	Accomplish class C repairs on the AN/UGC-13 (mod) teletypewriter sets on a semi-annual basis in support of the PMS requirements (MIP TD-46/1-A7 S-1R applies).	3.13.1.2
15	Mk 77 input/output console	Accomplish class C repairs on the Mk 77 input/output console teletypewriter equipment in support of the PMS requirements (MIP 5ORD005/2-97 A-1).	3.13.2.2
16	AN/SRA-33 antenna coupler	Accomplish class C repairs on the AN/SRA-33 antenna coupler at the depot level during each SRA. (Depot personnel should train ship's force personnel to repair AN/SRA-33 antenna couplers during these SRAs.)	3.6.6
		Regular Overhaul Requirements	
17	AN/URT-23( ) HF transmitter	Accomplish class C repairs as required by POT&I and CSMP.	3.2.5
18	R-1051( )/URR HF transmitter	Accomplish class C repairs as required by POT&I and CSMP.	3.3.7
19	R-390A/URR HF receiver	Accomplish class C repairs as required by POT&I and CSMP.	3.4.4
20	AN/URA-38 antenna coupler	Accomplish class B overhaul in accordance with MIP C-389/1-66.	3.5.2
21	AN/SRA-33 antenna coupler	Accomplish class C repairs as required by POT&I and CSMP.	3.6.7
22	AS-390A/SRC antenna	Accomplish class B overhaul in accordance with MIP C-405/3-14	3.8.2
23	AN/VRC-46 transceiver	Accomplish class C repairs as required by POT&I and CSMP.	3.9.2
24	AN/URC-80 transceiver	Accomplish class C repairs as required by POT&I and CSMP.	3.10.3
25	AN/WRR-3( ) receiver	Accomplish class C repairs as required by POT&I and CSMP.	3.11.2
26	Model 28 teletypewriter sets and the Mk 77 input/output console teletype equipment	Accomplish class B overhaul on all model 28 teletypewriter sets and the Mk 77 input/output console teletype equipment.	3.13.1.1 3.13.2.2
		PMS Changes	
27	Mk 77 input/output console teletype equipment	Revise the PMS documentation on the Mk 77 input/output console to reflect the FT's responsibility for the maintenance of the console's electronics and on RM's (NEC-2342) responsibility for the teletype equipment. The following maintenance requirements should be accomplished by an RM (NEC-2342) rather than the FTs: MIP 5ORD005/2-97 M-3/Q-5, M-6, Q-1, S-1, and A-1 MIP 5ORD005/CI-46 R-1 through R-54.	3.13.2.2
		Reliability and Maintainability Improvements	
28	Model 28 teletypewriter sets	Standardize the model 28 teletypewriter suites through the respective classes at BOH or as soon thereafter as feasible.	3.13.1.2
29	AN/UGC-6( ) teletypewriter sets	Update all AN/UGC-6( ) teletypewriter sets to the AN/UGC-6K model at BOH.	3.13.1.2
30	AN/UGC-16 teletypewriter sets	Replace the AN/UGC-16 teletypewritor sets in the CG-26 Class, with the AN/UGC-6K or AN/UGC-6K teletypewriter sets at BOH.	
31	R-1051( )/URR receiver	Label the different R-1051( )/URR receivers and the respective modules with warning labels which show model type and module substitution applicability.	3.3.5
		Integrated Logistics Support Improvements - None	
		IMA-Level Improvements - None	
		Depot-Level Improvements - None	

LIST OF REFERENCES

The following selected references were used as the basis for the review of experience of the exterior radio communications system:

1. *Ship Type Electronic Plan Key and Equipment-to-Subcategory Cross Reference (C)*, NAVSHIP 0900-001-2000, dated 1 January 1974.
2. Ship System Staging Diagrams for CG-16 and CG-26 Class Ships, dated July 1978.
3. Telecons with NAVELEX, March through May 1979.
4. Ship visits to the USS DALE (CG-19) and the USS WAINWRIGHT (CG-28), April through May 1979.
5. ShipAlts CG-16-1057 and CG-26-0377, AN/WSC-3 SATCOM installation.
6. *System Maintenance Analysis (SMA), FF-1052 Class Exterior Radio Communications System*, ARINC Research Publication 1652-03-1-1673, October 1977.
7. *System Maintenance Analysis (SMA), DDG-37 Class Exterior Radio Communications System*, ARINC Research Publication 1652-03-02-1777, June 1978.
8. Navy Material Data List (NMDL), dated 1975.
9. Generation IV MDS Part and Maintenance Data for CG-16 and CG-26 Classes, January 1970 through December 1977.
10. CASREP Narrative summaries, dated January 1972 through September 1978.
11. Ship Equipment Configuration Accounting System (SECAS) Reports for CG-16 through CG-34, dated 1978.
12. Allowance Parts List (APL) for selected components of the Exterior Radio Communications System.
13. DDEOC Repair Requirements for BOH (CG-16/26 Classes), dated August through July 1977.
14. Technical Manual, *Radio Transmitting Set, AN/URT-23*, NAVSHIPS 0967-191-7010, 15 April 1967.
15. Technical Manual, *Radio Transmitting Set, AN/URT-23*, NAVSHIPS 0967-456-9010, 1 January 1974.

LIST OF REFERENCES

The following selected references were used as the basis for the review of experience of the exterior radio communications system:

1. *Ship Type Electronic Plan Key and Equipment-to-Subcategory Cross Reference (C)*, NAVSHIP 0900-001-2000, dated 1 January 1974.
2. Ship System Staging Diagrams for CG-16 and CG-26 Class Ships, dated July 1978.
3. Telecons with NAVELEX, March through May 1979.
4. Ship visits to the USS DALE (CG-19) and the USS WAINWRIGHT (CG-28), April through May 1979.
5. ShipAlts CG-16-1057 and CG-26-0377, AN/WSC-3 SATCOM installation.
6. *System Maintenance Analysis (SMA), FF-1052 Class Exterior Radio Communications System*, ARINC Research Publication 1652-03-1-1673, October 1977.
7. *System Maintenance Analysis (SMA), DDG-37 Class Exterior Radio Communications System*, ARINC Research Publication 1652-03-02-1777, June 1978.
8. Navy Material Data List (NMDL), dated 1975.
9. Generation IV MDS Part and Maintenance Data for CG-16 and CG-26 Classes, January 1970 through December 1977.
10. CASREP Narrative summaries, dated January 1972 through September 1978.
11. Ship Equipment Configuration Accounting System (SECAS) Reports for CG-16 through CG-34, dated 1978.
12. Allowance Parts List (APL) for selected components of the Exterior Radio Communications System.
13. DDEOC Repair Requirements for BOH (CG-16/26 Classes), dated August through July 1977.
14. Technical Manual, *Radio Transmitting Set, AN/URT-23*, NAVSHIPS 0967-191-7010, 15 April 1967.
15. Technical Manual, *Radio Transmitting Set, AN/URT-23*, NAVSHIPS 0967-456-9010, 1 January 1974.

16. Technical Manual, *Receiver Set, Satellite Signal, AN/SSR-1( )*, NAVSHIPS 0967-LP-541-9010, 1 April 1967.

17. Technical Manual, *Antenna Coupler Group, AN/URA-33*, NAVSHIPS 0967-037-8000, 12 May 1966.

18. Technical Manual, *Satellite Communications Set, AN/WSC-3*, NAVELEX 0967-LP-545-4050/4060/4070, 15 May 1975.

19. NAVELEX Instruction P4110.45 (ILSP for AN/WRC-1 Family, April 1975).

20. Telecon to Parts Procurement Manager, SPCC, 6 June 1979.

21. Telecon with NAVSEA 931 Logistics Support Manager, March 1979.

22. Generation IV MDS Part and Maintenance Data for CG-16 and CG-26 Class, January 1970 through December 1977.

23. *DDEOC Selected Items for Analysis List, CG-16 and CG-26 Classes*, dated February 1979 (ARINC Research Publication 1653-06-TR-1875.)